Muelleria Vol. 11: 51–93 (1998)

Zygnemataceae (Chlorophyta) in Australia: a Reassessment of Records and a Key to Accepted Taxa

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Abstract

A synopsis and assessment are provided of the 100 specific and subspecific records of Zygnemataceae from Australia. Sixty-eight taxa are represented by a description, an illustration, a photograph and/or a herbarium specimen. Of these, 51 are accepted and included in a preliminary census of the family, the other 17 are rejected. Along with these 17, 32 of the 100 species were insufficiently documented (no description, illustration or herbarium record) to allow assessment. A total of 49 species are therefore rejected from the census. A key is provided to the accepted species.

Introduction

The family Zygnemataceae are represented in a wide range of freshwater habitats throughout Australia and the world. Although 100 species have been reported from Australia (Day *et al.* 1995), there has been no critical study to assess the validity of these records. Few records are well-documented in the literature and/or represented by voucher material in herbaria. In our study, we assessed all literature records, verifying the names used against available literature and where possible, relevant voucher material. The resulting synopsis and assessment are an important and necessary prelude to a thorough revision of the family which must include examination of type material, and extensive collection and culture studies.

Methods

In addition to evaluating all published reports of Zygnemataceae from Australia, we examined some unpublished records and all specimens received from Australian herbaria. We requested on loan all fertile material of Zygnemataceae from PERTH, DNA, AD, BRI, NSW, CANB, CBG and HO. All known literature records (Day *et al.* 1995) and fertile herbarium material from Australia were compared with the available literature. These records are listed under the heading *Specimens Reported* or under *Specimens Examined* if herbarium material was available. Where possible, existing slides were examined or, if necessary, new slides were prepared from herbarium material. The *Description of Australian Specimens* combines all available published information on the taxon in Australia as well as any data obtained from voucher material.

Slides of voucher material were made by placing a drop of a detergent solution on a small section of the dried voucher specimen to enable a few filaments to be lifted off. The filaments were then soaked in an eyeglass of the same solution and warmed on a hot-plate to allow rehydration. They were stained with 1% Aniline Blue (or other appropriate stain) for about ten minutes, washed in a water bath, then left in a drop of 10% Karo ™ Corn Syrup (with 1% phenol) for at least 2 minutes. The filaments were then placed in a drop of 40% Karo ™ Corn Syrup (with 1% phenol)

on a microscope slide where a cover slip was gently placed on top. The cover-slip was weighted down whilst the slide dried.

Species reported by Stephen Skinner (1980, 1983) to occur in Australia are accepted based on his published accounts rather than by examination of the microscope slides lodged at AD. The descriptions provided by McLeod (1975) appear to be based largely on non-Australian literature reports. For this reason we have only included information from McLeod's thesis in the *Description of Australian Specimens* when it is explicitly based on Australian material (e.g. *Mougeotia oblongata*). However, we have accepted her determinations when the data presented are consistent with published descriptions. The subfamilial groups used in Entwisle (1989) were based on vegetative features and can not be compared to species definitions based largely on reproductive structures.

Diagnostic Features

Genera in the Zygnemataceae are distinguished on the basis of gross chloroplast morphology, the conspicuousness of the conjugation tube, and the presence or absence of mucilaginous material in the gametangia following zygospore formation.

Species are distinguished by a combination of vegetative and reproductive features. The most important vegetative characters are the shape and size of cells, and the shape, number and arrangement of chloroplasts. Important reproductive features include: type of conjugation, whether lateral and/or scalariform; the morphology of the conjugation tube; the shape of the gametangia; and the shape and ornamentation of the zygospores. The wall of the zygospore is generally 3-layered and the *middle wall* is most taxonomically important. The *middle wall* is variously coloured and/or ornamented under light microscopy (additional characters are provided by scanning electron microscopy), the *outer wall* is usually colourless and transparent (or sometimes absent, e.g. in *Mougeotia*), and the *inner wall* is thin and usually obscure. Gametangial residues may adhere to zygospores in *Mougeotia*.

Accepted Taxa

From published data and in some cases material examined, we accept the following taxa as present in the Australian flora. That is, the description of the Australian specimens is compatible with the protologue or descriptions provided in major monographs. These names constitute a first census of the Zygnemataceae in Australia.

DEBARYA Wittr.

Vegetative cells with elongate axial chloroplasts extending the length of the cell; zygote not separated from gametangia by special walls; cytoplasmic residue not remaining in the gametangia; sporangia filled with pectic cellulose-colloid.

1. **Debarya hardyi** G.S. West, *J. Linn. Soc., Bot.* 39: 51 (1909).

Known Distribution: Australia.

Specimen Reported: VICTORIA: Yan Yean Reservoir, *G.S. West*, i.1906 (West 1909).

Description of Australian Specimens: Vegetative cells 6.5-7.5 µm in diameter, 9-16 times as long as broad, 2–4 pyrenoids in single series with regular arrangement; conjugation scalariform; zygospores quadrate, sides straight or very slightly concave, sometimes thickened, corners thickened and horned, horns cylindrical and solid; skin of the horn delicate and lamellate.

Taxonomic Assessment: West (1909, 51) states that 'this is the narrowest described [sic] species of the genus *Debarya*, and in outward appearance presents many resemblances to *Mougeotia gracillima*.' Mature spores were absent from the material examined by West (1909), but the chloroplast shape seems typical of the subfamily Mougeotioideae rather than Zygnemoideae and the narrow filaments are diagnostic of this species. Transeau (1951, 77) suggests that 'it is possible that this alga may, when fully known, be placed in *Zygnemopsis*.' The species has not been collected since the type collection.

MOUGEOTIA C. Agardh

Vegetative cells with elongate axial chloroplasts extending the length of the cell; zygote separated from gametangia by special walls; cytoplasmic residue remaining in the gametangia.

2. Mougeotia acadiana Transeau, *Trans. Amer. Microscop. Soc.* 53: 224 (1934).

Known Distribution: North America, Europe, Australia.

Specimen Reported: NORTHERN TERRITORY: Alligator River Region, Nankeen Billabong, *H.U. Ling and P.A. Tyler*, 13.iii.1979 (Ling and Tyler 1986).

Description of Australian Specimens: Vegetative cells 265–305 μm long, 23–30 μm in diameter; zygospores brown, with a furrow in the middle and a circular flange at each end.

Taxonomic Assessment: *Mougeotia acadiana* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 100–400 μm long, 43–54 μm in diameter; chloroplasts with numerous scattered pyrenoids; scalariform conjugation; distinctly geniculate gametangia; zygospores cylindrical-ovoid, 57–78 μm long, 51–70(73) μm in diameter, usually with concave sides and convex ends, the smooth and yellow middle wall thickened, wholly within the greatly enlarged conjugation tube. Although the filaments from the Northern Territory are narrower than those reported generally for *M. acadiana*, the shape of the zygospores and position in the conjugation tube matches that species. The illustrations in Ling and Tyler (1986) resembles those of Skuja (1949) and Transeau (1926). However, despite the disparity in size of the vegetative filaments, the Australian material is retained under the name *M. acadiana*. This collection could equally be referred to *M. laetevirens* which it matches more closely in vegetative diameter.

3. Mougeotia laetevirens (A. Braun) Wittr. in Wittr. & Nordst., *Bot. Not.* 1877: 23 (1877). *Craterospermum laetevirens* A. Braun, *Alg. Unicell.* 60 (1855).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1892, 1895; Bailey 1893, 1895, 1913); Queensland University Lake, St Lucia, *J.A. McLeod*, [s. d.] (McLeod 1975), Stradbroke Island, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Royal Botanic Gardens, Sydney, *G.I. Playfair*, 1916–17; Lismore, *G.I. Playfair*, 1916–17 (Playfair 1918).

Specimen Examined: QUEENSLAND: Big Bend area of Burdekin River, *A.B. Cribb 925.19*, 5.ix.1981 (BRI; Cribb 1984).

Description of Australian Specimens: Vegetative filaments 255–408 μm long, (22–)27–44 μm in diameter; pyrenoids 10–20 per chloroplast, either irregularly scattered or arranged in two lines at the edges, usually small (2–4 μm in diameter) occasionally larger (10 μm in diameter); conjugation scalariform; zygospores ovoid to oblong, rarely globular, 'more or less pulley-wheel form' (Cribb 1984, 103), 40–63

μm long, 42–53 μm in diameter, contained within the conjugation tube, middle wall smooth and yellow-brown (Cribb 1984) or glistening white and stratified (Moebius 1895). The description is taken from published accounts, the herbarium specimen not providing any additional information.

Taxonomic Assessment: *Mougeotia laetevirens* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 65–350 μm long, 34–41 μm in diameter; chloroplasts with numerous scattered pyrenoids; conjugation scalariform; gametangia distinctly geniculate; zygospores, wholly within the conjugation tube, polymorphic, usually short-cylindrical, 45–72(–75) μm long, 36–47(–60) μm in diameter, with concave sides, sometimes compressed-globose or irregular, middle wall smooth and yellow-brown; aplanospores ovoid to obliquely ovoid. Nearly all these features are present in the described Australian material. Furthermore, illustrations, such as Transeau's (1951) of North American representatives of *M. laetevirens*, closely match the Australian material in vegetative and zygospore morphology. Moebius's (1895) description of the middle wall is at odds with all published data from Australia and overseas, but in other respects the specimen described by Moebius is referable to *M. laetevirens*. All Australian literature reports of *M. laetevirens* are accepted.

4. **Mougeotia parvula** Hassall, *Ann. Mag. Nat. Hist.* 11: 434 (1843) var. **parvula**.
Mougeotia parvulus Hassall, *Hist. Brit. Freshwater Alg.* 169, t. 45 figs 2–3 (1845).

Known Distribution: North and South America, Europe, North Africa, Asia, Australia.

Specimen Reported: NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917).

Specimen Examined: QUEENSLAND: Blackdown Tableland, *A.B. Cribb 805.1*, 6.ix.1974 (BRI; Cribb 1976).

Description of Australian Specimens: Vegetative cells 40–75 μm long, c. 9 μm in diameter; conjugation scalariform; zygospores (and/or aplanospores) in the conjugating tubes, globose, c. 15 μm in diameter and yellow-brown.

Taxonomic Assessment: *Mougeotia parvula* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 30–140 μm long, 6–13 μm in diameter, chloroplast usually occupying two-thirds of the cell, with 4–8 pyrenoids; conjugation scalariform; zygospores formed wholly in the conjugating tube, globose, 13–25(–36) μm in diameter, middle wall thick, smooth and brown; aplanospores obliquely ovoid, 20–24 μm long, 16–20 μm in diameter. The Queensland collection matches other published descriptions of *M. parvula* and is accepted here and referred to the typical variety (see *Mougeotia parvula* var. *angusta* in rejected names). The listing in Playfair (1917) includes no documentation so the New South Wales collection cannot be verified.

5. **Mougeotia scalaris** Hassall, *Ann. Mag. Nat. Hist.* 10: 45 (1842). *Mesocarpus scalaris* (Hassall) Hassall, *Hist. Brit. Freshwater Alg.* 166 (1845); ?*Zygnema scalare sensu* Kütz., *in litt.* (1882a); *Mougeotia tenuis* Kütz., *Sp. alg.* 446 (1849), *non Mougeotia tenuis* (Cleve) Wittr. (1872).

Known Distribution: Europe, Asia, North Africa, New Caledonia, Australia.

Specimens Reported: NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917). VICTORIA: [s. loc.] (Kützing 1882a, 1882b; as *Zygnema scalare* and *Mougeotia tenuis* respectively).

Specimen Examined: QUEENSLAND: Nerang River, *A.B. Cribb 845.4*, 14.vi.1976 (BRI).

Description of Australian Specimens: Vegetative cells c. 40 µm in diameter; conjugation scalariform; gametangia 18–24 µm in diameter; zygospores formed wholly in the conjugation tube; globose c. 30 µm in diameter. Slide preparations from the herbarium material did not provide additional information.

Taxonomic Assessment: *Mougeotia scalaris* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984) by vegetative cells 40–180 µm long, 20–34 µm in diameter; chloroplast with 4–10 pyrenoids in a single straight or slightly curved row; gametangia straight or slightly curved, 20–34 µm in diameter; conjugation scalariform; zygospores formed wholly in the conjugation tube, ovoid to globose, 27–40 µm long, 25–31 µm in diameter, middle wall smooth and yellow-brown. The Queensland material examined matches the current literature descriptions and is therefore retained under *M. scalaris*. The Playfair (1917) and Kützing (1882a, 1882b) reports include no documentation and cannot be evaluated (De Toni 1889 treats *Mougeotia tenuis* Kütz. as a synonym of *M. scalaris*)

6. Mougeotia sestertisignifera Stephen Skinner, *Trans. & Proc. Roy. Soc. South Australia* 107: 223–230 (1983).

Known Distribution: Australia.

Specimen Reported: SOUTH AUSTRALIA: SA Region 13, Bool Lagoon, *J. Roberts and K. Preace*, 5.xi.1982 (Skinner 1983).

Description of Australian Specimens: Vegetative filaments 70–200 µm long, 22–26 µm diameter, end-walls plane; (4–)5–10 scattered pyrenoids; conjugation scalariform; zygospores in broad conjugation tube with arms extending almost to fill both gametangia, H-shaped, 60–80 µm in diameter, outer wall smooth, middle wall lamellate and golden.

Taxonomic Assessment: *Mougeotia sestertisignifera* was newly described in Australia by Skinner in 1983. Skinner (1983, 225) notes that in having an 'H-shaped spore, this taxon is similar to members of the genus *Temnogametum* but does not appear to have specialized smaller gametangial cells, nor does its spore show a sigmoid process.' Vegetatively the material is similar to *Mougeotia* species with quadrate spores.

7. Mougeotia subcrassa G.S. West, *J. Linn. Soc., Bot.* 39: 50 (1909).

Known Distribution: Australia.

Specimen Reported: VICTORIA: Yan Yean Reservoir, *G.S. West*, x–xi.1905 (West 1909).

Description of Australian Specimens: Vegetative cells 41.5–43 µm in diameter, 6–6.5 times longer than broad; chloroplasts large, with 15–24 pyrenoids; conjugation scalariform, conjugation tube straight or very slightly curved; zygospores globose, 40–41 µm in diameter, middle wall smooth.

Taxonomic Assessment: The relatively small size of spores as compared with the diameter of the vegetative cells distinguishes this species from *M. scalaris* and *M. crassa* (West 1909). It is also distinguished from the former by the much greater thickness of its vegetative cells and large chloroplasts with more numerous pyrenoids; and from the latter by its slightly longer and thinner vegetative cells. It is known only from the type collection.

8. Mougeotia victoriensis G.S. West, *J. Linn. Soc., Bot.* 39: 51 (1909).

Known Distribution: Australia.

Specimens Reported: QUEENSLAND: Toonpan Creek, *M. Laird*, 18.vi.1954 (Laird 1956). VICTORIA: Yan Yean Reservoir, *G.S. West*, xi.1905 (West 1909).

Description of Australian Specimens: Vegetative cells 11.5–12 µm in diameter, 9.5–14 times as long as broad; chloroplasts elongate, with 2–7 (usually 5–6) pyrenoids arranged in a single series; conjugation scalariform; gametangia bent;

zygospores formed in conjugating tube, globose, 21–24 µm in diameter, middle wall smooth; pectic material developing around sporangium and beyond the outer sides of the gametangia, entire mucus coat 60–63 µm in diameter.

Taxonomic Assessment: Mougeotia victoriensis is similar to *M. parvula* but is distinguished by its slightly thicker, somewhat elongate, vegetative cells and by the large (almost three times the diameter of the spore) gelatinous envelope surrounding the spores West (1909). The Queensland report Laird (1956) includes no documentation and cannot be verified. The type collection therefore remains the only confirmed record.

SPIROGYRA Link

Vegetative cells with 1-several parietal, spiral chloroplasts; conjugating tubes formed by one or both gametangia before conjugation; outer layer of vegetative cell walls made of pectic compounds, which usually disappear during conjugation.

9. Spirogyra australiensis Moebius, *Abh. Senckenberg. Naturf. Ges.* 18: 310–50 (1895).

Known Distribution: Australia.

Specimens Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1895; Bailey 1895, 1913; Pigram 1909); Capalaba and lagoon east of Maryborough, *J.A. McLeod,* [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells c. 50 µm in diameter, 2–3 times as long as broad, end-walls plane; chloroplasts single with 2.5–3 revolutions; gametangia as long as, or generally longer than vegetative cells, not swollen, the conjugation canal issuing from the male filament is longer than that issuing from the female filament; zygote ovoid, 74–77 µm long, 40–45 µm in diameter, with a 'thin, internal, hyaline membrane and an external thicker one, finely verrucose and dusky green.' Bailey (1895, 34).

Taxonomic Assessment: *Spirogyra australiensis* is similar to *S. velata* and *S. dædalea* but differs in vegetative cell and zygote morphology. It also resembles *S. punctata* but differs in the gametangial morphology. All Australian reports are based on the type collection.

10. Spirogyra baileyi W. Schmidle, *Flora* 82: 297 (1896).

Known Distribution: Brazil, Africa, Australia.

Specimens Reported: QUEENSLAND: Enoggera district, *W. Schmidle*, 27.iv.1895 (Schmidle 1896; Bailey 1898, 1913); Bardon and Gympie, *J.A. McLeod,* [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells 128–200 µm long, 20–24 µm in diameter, end-walls plane; chloroplasts 2, 'fairly broad', with 3–4 revolutions; conjugation tubes formed by both gametangia; gametangia shorter than vegetative cells, rather strongly inflated, c. 60 µm long, c. 32 µm in diameter; zygotes elliptical, c. 48–53 µm long, 26.5–28 µm in diameter, middle wall smooth.

Taxonomic Assessment: The diagnostic features of the species, according to Schmidle (1896), are the long and narrow vegetative cells and the two chloroplasts per cell. The type of *Spirogyra baileyi* is Australian and the taxa is recognized in all major monographs. It has since been found in Africa (Gauthier-Liévre 1965) and Brazil (Dias 1992).

11. Spirogyra bellis (Hassall) Cleve, *Nova Acta Regiae Soc. Sci. Upsal.* ser. 3, 6: 18 (1868). *Zygnema belle* Hassall, *Hist. Brit. Freshwater Alg.* t. 24 (1845); *Spirogyra subaequa* Kütz., *Phycol. Germ.* 223 (1845), equated with *S. bellis* by De Toni (1889).

Known Distribution: North America, Africa, India, Australia.

Specimens Reported: QUEENSLAND: Port Curtis, *T.L. Bancroft*, v–vi.1892 (Bailey

1895, 1913; Moebius 1895; Pigram 1909); Elliot Heads and Capalaba, *J.A. McLeod*, [s. d.] (McLeod 1975). VICTORIA: [s. loc.] (Kützing 1882b, as *Spirogyra subaequa*).

Description of Australian Specimens: Vegetative cells 65–70 µm in diameter, 3–4 times as long as broad, end-walls plane; chloroplasts 4–5, nearly straight or making up to 2 spirals.

Taxonomic Assessment: *Spirogyra bellis* is characterized (Borge 1913; Transeau 1951; Gauthier-Liévre 1965; Kadłubowska 1972; Dillard 1990) by vegetative cells 90–350 µm long, 65–80 µm in diameter, with plane end-walls; 5-6 chloroplasts making 0.1–1 turn; conjugation tubes formed equally by both gametangia; gametangia shortened or inflated; zygospores lenticular, 60–90(–105) µm long, (45–)48–60 µm in diameter, outer spore wall thickened, smooth and colourless, middle wall thickened, irregularly pitted and brown. Randhawa (1959), however, describes *S. bellis* as having vegetative cells 60–65 µm in diameter, with up to 7 chloroplasts, zygospores oval or globose, 80–85 µm long, 54–64 µm in diameter, with the middle wall smooth, thick, brownish yellow in colour, and gametangia strongly swollen on both sides. The cell dimensions and number of chloroplast spirals in the vegetative filament illustrated by Pigram (1909; the fertile filament is after Petit 1880) do not match the above descriptions and his record is therefore excluded. Moebius (1895, as translated in Bailey 1895, 36) describes his specimen as having filaments '...distinguished by a thick gelatinous sheath (as much as 100 µm thick) and this together with the agreement in dimensions and other characteristics makes the determination pretty certain.' Pigram (1909) did not observe such a sheath in his specimens, commenting that 'it is probably not persistent.' This feature is not mentioned in any of the above descriptions and we discount it as a diagnostic character for this species. In the absence of reproductive material, the Brancroft specimen could be referable to other species of *Spirogyra*, such as *S. echinospora* Blum. The Victoria record is not documented, and is also excluded from the census. The description provided by McLeod (1975), however, is consistent with other descriptions of this taxon and the name is accepted in this census.

12. Spirogyra columbiana Czurda, *Süsswasserflora* 9: 190 (1932). *Spirogyra neglecta* var. *anylacea* Playfair, *Proc. Linn. Soc. New South Wales* 43: 497–543 (1918).

Known Distribution: North and South America, Europe, South Africa, Asia, Australia.

Specimen Reported: NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1916–1918 (Playfair 1918).

Description of Australian Specimens: Vegetative cells 60–260 µm long, 46–54 µm in diameter, end-walls plane; chloroplasts 2–3, making 1.5–3.5 turns; pyrenoids up to 10–12 µm in diameter; zygospores ellipsoid, 74–90 µm long, 48–50 µm in diameter.

Taxonomic Assessment: *Spirogyra neglecta* var. *amylacea* is listed by Kadłubowska (1972) as a synonym of *S. columbiana* Czurda and the description he gives is generally consistent with that of Playfair (1918). *Spirogyra columbiana* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 90–180 µm long, 46–54 µm in diameter, with plane end-walls; chloroplasts 1–3; conjugation scalariform, conjugation tubes formed equally by both gametangia; fertile and sterile cells both cylindrical; zygospores ellipsoid, 59–124 µm long, 42–70 µm in diameter, middle wall thickened, smooth and yellow-brown with a distinct suture. Playfair (1918, 513) commented that 'the chloroplasts have become impregnated with amylum and have broken up into minute irregular grains. The central ridge, however, is generally still noticeable.'

13. Spirogyra communis (Hassall) Kütz., *Sp. alg.* 439 (1849). *Zygnema commune* Hassall, *Hist. Brit. Freshwater Alg.* 148, t. 28 fig. 5–6 (1845).

Known Distribution: North and South America, Europe, North Africa, Asia, New Caledonia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: [s. loc., s. d.] (Pigram 1909); Mt Tambourine, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Hawkesbury River, *F. Mueller*, [s. d.] (Kützing 1882b).

Specimen Examined: QUEENSLAND: Lower Dry Creek, Kroombit Tops, *A.B. Cribb 985.2*, 11.xii.1983 (BRI; Cribb 1986).

Description of Australian Specimens: Vegetative cells 4–6(–12) times as long as broad, end-walls plane; chloroplast single, making 3–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia inflated on the conjugating side; zygospores lenticular to elliptical (calculated from illustration in Pigram 1909).

Vegetative cells 87–100 µm long, 25 µm in diameter, end-walls plane; chloroplast single, making 2.5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; zygospores ellipsoid, c. 48 µm long, c. 24 µm in diameter; middle wall smooth and yellow-brown (BRI).

Taxonomic Assessment: *Spirogyra communis* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Devi and Panikkar 1993) by vegetative cells (18–)19–25(–26) µm in diameter, 2–5 times as long, with plane end-walls and chloroplast single, making 1.5–4 turns; conjugation scalariform (occasionally lateral), conjugation tubes formed equally by both gametangia; gametangia cylindrical (rarely enlarged); zygospores ellipsoid, 35–69(–78) µm long, 18–23(–26) µm in diameter, outer spore wall thin, smooth and colourless, middle wall thickened, smooth and yellow to brown. Pigram's (1909) description and illustration do not match other published descriptions of *S. communis* and this report is excluded. So too is the report of Kützing (1882b), which includes no documentation and is not vouchered. However, the McLeod and Cribb collections from Queensland match the above description of *S. communis* and the name is retained in the census.

14. Spirogyra cylindrica Czurda, *Süsswasserflora* 9: 150 (1932).

Known Distribution: North America, Europe, Africa, China, Australia.

Specimen Reported: QUEENSLAND: Big Bend area of Burdekin River, *A.B. Cribb*, vi-vii.1981 (Cribb 1984).

Description of Australian Specimens: Vegetative cells 10–17.5 µm diameter, end-walls replicate; chloroplast single; conjugation scalariform, conjugation tube formed mainly by male gametangium; gametangia inflated on the conjugating side; zygospores ellipsoid, 25–28 µm in diameter, middle wall entirely smooth, yellow-brown.

Taxonomic Assessment: *Spirogyra cylindrica* is characterized (Czurda 1932; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Kargupta and Sarma 1992) by vegetative cells (91–)140–350 µm long, 9–19 µm in diameter, with replicate end-walls; chloroplast single, making 2.5–6 turns in the cell; conjugation lateral and scalariform, conjugation tubes formed almost wholly by the male gametangia; gametangia inflated towards the centre to 28–42 µm; zygospores ellipsoid 33–71(–95) µm long, 19–38 µm in diameter, middle wall smooth, and yellow-brown, The Australian report is concordant with this description and the name *S. cylindrica* is accepted here.

15. Spirogyra decimina (O.F. Müll.) Kütz., *Phycol. General.* 279 (1843). *Conferva decimina* O.F. Müll., *Nova Acta Acad. Sci. Imp. Petrop. Hist. Acad.* 3: 94, t. 2 fig. 3 (1785).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: Corinda, *C.T. White* (Bailey 1913); Indooroopilly, Bardon, Jimboomba, *J.A. McLeod*, [s. d.] (McLeod 1975). VICTORIA: [s. loc.], *Watts* (Hardy 1906; Kützing 1882a, 1882b; Watts 1887).

Specimen Examined: SOUTH AUSTRALIA: Adelaide, Torrens River, *F. Mueller*, i.1848 (MEL; Sonder 1852, 1880; Tate 1882).

Description of Australian Specimens: Vegetative cells 60-90 µm long, 25–45 µm in diameter. The specimen examined was poor and the cell contents have degenerated. Mueller's collections were determined by Kützing.

Taxonomic Assessment: *Spirogyra decimina* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 66–150 µm long, 32–42 µm in diameter, with plane end-walls; 2–3 chloroplasts making 1–2 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical or enlarged; zygospores ovoid to globose, 31–68(–73) µm long, 31–41 µm in diameter, middle wall smooth, yellow. Although the herbarium material examined (originally determined by Kützing) was consistent with the above description, it was sterile and could be referred to one of many species. Similarly, the literature reports for Victoria were determined from sterile material and cannot be assigned confidently to *S. decimina*. The Corinda record is not documented at all by Bailey (1913). However, the description provided by McLeod (1975) is consistent with this taxon and the name is accepted in this census. This species cannot be distinguished from *S. rivularis* in the vegetative condition.

16. Spirogyra ellipsospora Transeau, *Amer. J. Bot* 1: 294 (1914).

Known Distribution: North America, Central China, India, Australia.

Specimen Reported: NORTHERN TERRITORY: Alligator River Region, Jabiluka Billabong, *H.U. Ling and P.A. Tyler*, 4.vi.1979 (Ling and Tyler 1986).

Description of Australian Specimens: Vegetative cells cylindrical, 180–305 µm long, 110–120 µm in diameter, end-walls plane; chloroplasts 5, making many turns; conjugation scalariform, conjugation tubes from both gametangia, zygospores 195–203 µm long, 100–104 µm in diameter, ellipsoid or cylindrical-ellipsoid, middle wall smooth and yellow-brown.

Taxonomic Assessment: *Spirogyra ellipsospora* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 125–500 µm long, 125–150 µm in diameter, with plane end-walls; chloroplasts 3–8 making 4–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia, gametangia cylindrical; zygospores ellipsoid, apices more or less pointed, 160–255 µm long, 100–140 µm in diameter; outer spore wall thin, smooth and colourless, middle wall smooth and yellow-brown. The Australian specimen matches this description and is therefore accepted under the name *S. ellipsospora*.

17. Spirogyra farlowii Transeau, *Ohio J. Sci.* 16: 29 (1915). *Spirogyra grevilleana* var. *australis* Playfair, *Proc. Linn. Soc. New South Wales* 40: 310-62, pl. 42 fig. 2 (1915).

Known Distribution: North America, Europe, Asia, Australia.

Specimens Reported: NEW SOUTH WALES: Lismore, Wyrallah Road, *G.I. Playfair*, 1914 (Playfair 1915, 1917). TASMANIA: Freshwater Creek, Bakers Beach, Sorell, *H.J. Robertson*, 5.ix.1982 (unpublished illustration and description with AD *53982*).

Description of Australian Specimens: Vegetative cells 160–230 µm long, 30 µm in diameter, 5–15 times as long as broad, end-walls replicate; chloroplasts 1(–2) making 2.5–7 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia enlarged; zygospores ellipsoid, with pointed ends, c. 75 µm long, c. 50 µm in diameter.

Taxonomic Assessment: *Spirogyra farlowii* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 70–400 µm long, 23–30 µm in diameter, with replicate end-walls; 1 (rarely 2) chloroplast

making 2.5–6 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia; gametangia inflated to 39–60 µm; zygospores and aplanospores ellipsoid, ends more or less pointed, 48–96 µm long, 30–45 µm in diameter, middle wall smooth and yellow. Skinner (*in sched.*) made a comment on the specimen [AD *A53982*] that it 'is thought (Kek) to be equivalent to Playfair's (1915) *Spirogyra grevilleana* var. *australis* from the Richmond River near Lismore, NSW.' *Spirogyra grevilleana* var. *australis* is listed as a synonym of *S. farlowii* in Kadlubowska (1972), and both Australian records are consistent with the description above. *S. farlowii* is thus included in our census.

18. Spirogyra fennica Cederer., *Acta Soc. Fauna Fl. Fenn.* 55(2): 4 (1924).

Known Distribution: North America, Europe, South Africa, Asia, Australia.

Specimen Examined: QUEENSLAND: Bertie Creek, Cape York Peninsula, *A.B. Cribb 1188.6*, 10.iii.1992 (BRI).

Description of Australian Specimens: Vegetative cells c. 126 µm long, c. 21 µm in diameter, end-walls plane; chloroplast single, making up to 4 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia greatly inflated, 30–42 µm in diameter; zygospores ellipsoid, 48–63 µm long, 27–30 µm in diameter.

Taxonomic Assessment: *Spirogyra fennica* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadlubowska 1972, 1984) by vegetative cells 60–260 µm long, 15–21 µm in diameter, with plane end-walls; chloroplast single; conjugation scalariform (sometimes lateral), conjugation tubes formed equally by both gametangia; gametangia shortened and inflated to 34–39 µm in diameter; zygospores ellipsoid, 45–58 µm long, 24–31 µm in diameter, middle wall smooth and yellow-brown. The Australian collection is concordant with this description and the name *S. fennica* is accepted in our census.

19. Spirogyra frigida F. Gay, *Essai Monogr. Conjug.* 90, t. iv fig. 4 (1884).

Known Distribution: Europe, Asia, Australia.

Specimen Reported: SOUTH AUSTRALIA: Ibis rookery, Bool Lagoon, *L. Lloyd*, 15.ix.1982 (Skinner 1983)

Description of Australian Specimens: Vegetative cells (16–)18–23 µm in diameter, 4–10 times as long as broad, end-walls replicate; chloroplast single, making 5–9 turns, pyrenoids numerous; conjugation scalariform, gametangial tube almost cylindrical, unequal, inflated towards the gametangial tube; zygospores elliptical, 70–75 µm, 35 µm in diameter, middle wall smooth and pale-brown.

Taxonomic Assessment: *Spirogyra frigida* is characterized (Kadlubowska 1972, 1984) by vegetative cells sometimes swollen, 16–20 µm in diameter, 3.5–12 times as long as broad, end-walls replicate; chloroplast single; conjugation scalariform, gametangia enlarged, conjugation tubes normally formed equally by both gametangia; zygospores ellipsoid, attenuated, 48–103 µm long, 20–35 µm in diameter, middle wall smooth and yellow. The Australian specimen closely matches the descriptions of *S. frigida* by Kadlubowska and this name is accepted in the census.

20. Spirogyra grevilleana (Hassall) Kütz., *Sp. alg.* 438 (1849). *Zygnema grevillii* Hassall, *Hist. Brit. Freshwater Alg.* 149, pl. 31 figs 1, 2 (1845); *Spirogyra quinina* var. *inaequalis* Sonder *nom. nud.* (1880).

Known Distribution: North America, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: [s. loc., s. d.] (Pigram 1909); Sandgate Lagoon and Gympie, *J.A. McLeod*, [s. d.] (McLeod 1975). TASMANIA: [s. loc., s. d.] (Sonder 1852, as '*S. quinina* b *inaequalis*'; Sonder 1880).

Description of Australian Specimens: Vegetative cells 28–41 µm in diameter, 5 times as long as broad, end-walls replicate; chloroplast single, making 3 turns; conjugation scalariform, conjugation tubes formed by both gametangia, sometimes mostly by the male, vegetative cells of the conjugating filament not swollen, gametangia inflated, fusiform; zygospores ellipsoid (calculated from illustration in Pigram 1909).

Taxonomic Assessment: *Spirogyra grevilleana* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 60–325 µm long, 22–33 µm in diameter; with replicate end-walls; chloroplast 1 (sometimes 2), making 4–8 turns; conjugation scalariform and lateral, conjugation tubes formed largely by male gametangia; gametangia fusiform 'inflated' 36–43 µm in diameter; zygospores globose to ovoid, (35–)60–90 µm long, 30–42 µm in diameter, outer spore wall thin, smooth and colourless, middle wall smooth and yellow often with a distinct fissure-line. Although with filaments generally broader than reported elsewhere, the Queensland records are consistent with *S. grevilleana* and the name is accepted here. The reports by Sonder are not documented and cannot be evaluated here.

21. Spirogyra inflata (Vaucher) Kütz., *Phycol. General.* 279 (1843). *Conjugata inflata* Vaucher, *Hist. Conferv. Eau Douce* 68, t. 5 fig. 3 (1803).

Known Distribution: North America, Europe, North Africa, Asia, Australia.

Specimens Reported: NORTHERN TERRITORY: Alligator River Region, Umbungbung Billabong, *H.U. Ling and P.A. Tyler*, 30.v.1979 (Ling and Tyler 1986). QUEENSLAND: Upper Walsh River, *T.L. Bancroft* (Bailey 1913; Borge 1911); Upper Brookfield, and Reynolds Creek, *J.A. McLeod*, [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells c. 103 µm long, 17–20 µm in diameter, end-walls replicate; chloroplasts single; conjugation scalariform; conjugation tubes formed equally by both gametangia; gametangia inflated, fusiform; zygospores ellipsoid, smooth, 50–56 µm long, 26 µm in diameter.

Taxonomic Assessment: *Spirogyra inflata* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 45–230 µm long, 15–21 µm in diameter, with replicate end-walls; chloroplast single, making 2.5–6 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia, gametangia inflated, 35–48 µm in diameter; zygospores and aplanospores ellipsoid, 50–76 µm long, 27–36 µm in diameter, middle wall thickened, smooth and yellow. These features are consistent with records documented by McLeod (1975) and Ling and Tyler (1986), and the name *S. inflata* is retained here. Bancroft's (Bailey 1913; Borge 1911) report of the species includes no documentation or illustration and cannot be assessed.

22. Spirogyra irregularis Nägeli in Kütz., *Sp. alg.* 440 (1849).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimen Reported: SOUTH AUSTRALIA: Region 13, Bool Lagoon, *L. Lloyd*, 15.ix.1982 (Skinner 1983).

Description of Australian Specimens: Vegetative cells 24–30 µm in diameter, 2–8 times as long as broad, end-walls lenticular; chloroplasts 2–3, making 3–7 turns, pyrenoids numerous; conjugation scalariform, conjugation tubes cup-shaped and of almost equal halves, often arising towards ends of cells; gametangia not inflated; zygospores smooth, slightly compressed ovoid, 75–85(–90) µm long, 30 µm in diameter, middle wall dark yellow-brown.

Taxonomic Assessment: *Spirogyra irregularis* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dias 1992; Habib 1993) by vegetative cells 65–250 µm long, 32–37 µm in diameter, with plane end-walls;

chloroplasts 2–4, making 0.5–1 turn; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical; zygospores ellipsoid to cylindrical-ellipsoid, 45–90 µm long, 30–36(–39.5) µm in diameter, middle wall smooth and yellowish-brown. Although the specimens reported from Australia have slightly narrower filaments and chloroplasts more spiralled, in all other respects it matches *S. irregularis* and the name is accepted here.

23. Spirogyra juergensii Kütz., *Phycol. germ.* 222 (1843).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimen Reported: NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917).

Specimen Examined: QUEENSLAND: Surveys Gulley, Lake Broadwater, *A.B. Cribb 1028.1*, 27.i.1985 (BRI; Cribb 1988).

Description of Australian Specimens: Vegetative filaments 54–300 µm long, 23.5–33 µm in diameter, end-walls plane; chloroplast single, making 4–7 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical or often somewhat inflated on the conjugating side; zygospores ellipsoid 47–66 µm long, 30–36 µm in diameter, middle wall smooth and golden.

Taxonomic Assessment: *Spirogyra juergensii* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Kargupta and Sarma 1992; Devi and Panikkar 1993) by vegetative cells 60–207 µm long, 24–33 µm in diameter, with plane end-walls; chloroplast single, making 2–5 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia and distended at the points of contact; gametangia cylindrical or enlarged toward the middle (to 34 µm); zygospores and aplanospores ellipsoid, (41–)50–75(–99) µm long, (22–)28-33 µm in diameter; outer spore wall thin, smooth and colourless, middle wall thicker, smooth and yellow. The Australian collections vary only slightly from this description and the name *S. juergensii* is accepted here.

24. Spirogyra longata (Vaucher) Kütz., *Phycol. General.* 279 (1843). *Conjugata longata* Vaucher, *Hist. Conferv. Eau Donce* 71, pl. 6 fig. 1 (1803).

Known Distribution: North and South America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Glasshouse Mountains, *T.L. Bancroft*, ix.1892 (Bailey 1895, 1913; Moebius 1895); [s. loc., s. d.] (Pigram 1909); Civil Airfield, Cairns, *M. Laird*, 9.vi.1954 (Laird 1956); Upper Brookfield, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Hawkesbury River, *F. Mueller*, 1882 (Kützing 1882b; Playfair 1917). VICTORIA: Berwick, *A.D. Hardy*, 12.v.1906 (Hardy 1906).

Specimen Examined: VICTORIA: Merri Creek, *R.A. Bastow*, ii.1899 (MEL).

Description of Australian Specimens: Vegetative cells 24–26 µm in diameter, 10 times as long as broad, end-walls plane, chloroplast single, making 4–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia, gametangia short, somewhat inflated, zygospores ovoid, somewhat elongated, c. 60 µm long, 22–44 µm in diameter, with rounded ends.

Taxonomic Assessment: *Spirogyra longata* (var. *longata*) is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Kargupta and Sarma 1992; Devi and Panikkar 1993) by vegetative cells 45–280 µm long, 26–38 µm in diameter, 2–10 times as long as broad with plane end-walls; chloroplast single, making 2–5 turns (0.5–1 turn; Kargupta and Sarma 1992); conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia, gametangia not swollen; zygospores ovoid to ellipsoid, sometimes globose, 50–83 µm long, 28–38 µm in diameter, middle wall smooth and yellow (usually

with a distinct fissure line; Dillard 1990). This description matches that of Moebius (1895) except for the non-inflated gametangia. Moebius (1895, as translated in Bailey 1895, 33) noted this one discrepancy but decided that the Bancroft specimen was 'more like [*S. longata*] than any other species.' We concur with this decision. McLeod's description is consistent with *S. longata* and it also is accepted here. The other collections are not sufficiently well documented to assess. This species is similar to *S. singularis*.

Spirogyra longata var. *elongata* Rab. has narrower, longer cells (22–24 µm in diameter, 4–12 times as long as broad) than the type and some Australian collections may be referable to this variety.

25. Spirogyra maxima (Hassall) Wittr., *Bot. Not.* 57 (1882). *Zygnema maximum* Hassall, *Ann. Mag. Nat. Hist.* 10: 36 (1842); *Spirogyra orbicularis* (Hassall) Kütz. *Sp. alg.* 442 (1849); *Spirogyra alternata* Kütz., *Sp. alg.* 442 (1849); *Zygnema alternatum* Hassall, *Hist. Brit. Freshwater Alg.* 139, pl. 20 (1845); *Spirogyra orbicularis, Spirogyra alternata* and *Zygnema alternatum* equated with *Spirogyra maxima* by De Toni (1889).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: [s. loc. , s. d.] (Pigram 1909). NEW SOUTH WALES: Tamworth, *D.A. Poster*, 1885 (Nordstedt 1886); Lismore, *G.I. Playfair*, xii.1912-i.1913 (Playfair 1914, 1917); Bardon, *J.A. McLeod*, [s. d.] (McLeod 1975). VICTORIA: [s. loc.] (Watts 1865, as *Zygnema alternatum*; Kützing 1882b, as *Spirogyra alternata*). TASMANIA: [s. loc.], *Stuart*, xii.1848 (Sonder 1852, 1880, both as *Spirogyra orbicularis*).

Description of Australian Specimens: Vegetative cells 120–340 µm long, 108–130 µm in diameter, end-wall plane, lateral walls 1–4 µm thick; chloroplasts 6, making 0.5–1(–3; Playfair 1914) turns; zygospores lenticular, 110–112 µm in diameter or ellipsoid-lenticular, 112–136 µm long, 100–116 µm wide and 84–92 µm thick.

Taxonomic Assessment: *Spirogyra maxima* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Habib 1993; Devi and Panikkar 1993) by vegetative cells 100–250 µm long, 114–140(–155) µm in diameter, with plane end-walls; chloroplasts (5–)6–7, making 0.2–0.8 of a turn; conjugation scalariform, conjugation tubes formed equally by both gametangia, gametangia cylindrical; zygospores lenticular, 100–140(–160) µm in diameter, 64–98 µm thick, outer wall thin, smooth and colourless, middle wall thickened, reticulate, finely punctate and golden-brown. The descriptions of Playfair (1914) and McLeod (1975), and the illustration of Pigram (1909) are consistent with this description of *S. maxima* and we believe the species occurs in Australia. The Kützing (1882b), Nordstedt (1886) and Sonder (1852; 1880) references include no documentation and can not be confirmed.

26. Spirogyra mirabilis (Hassall) Kütz., *Sp. alg.* 438 (1849). *Zygnema mirabile* Hassall, *Hist. Brit. Freshwater Alg.* 156, pl. 35 fig. 1-3 (1845).

Known Distribution: North America, Europe-Asia, Australia.

Specimens Reported: SOUTH AUSTRALIA: Hacks Lagoon, Cons. Pk, *L. Lloyd*, 15.ix.1982 (Skinner 1983); Noarlunga Ford, Onkaparinka River, *B.P. Thomas and S. Skinner*, 14.x.1971 (Skinner 1983). NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1916-1918 (Playfair 1918).

Description of Australian Specimens: Vegetative cells 230–245 µm long, 15–23 in diameter, end-walls plane; chloroplast single, making 3.5–4 turns; conjugation scalariform; gametangia swollen, 25–42 µm in diameter; zygospores ellipsoid, 44–93 µm long, 21–34 µm in diameter (Playfair 1918).

Vegetative cells 28–32 µm in diameter, 2.5–7 times as long as broad, end-walls plane; chloroplast single, making 4–8 turns, with numerous large pyrenoids; 'aplanospores (parthenospores?) in series, spherical to ellipsoid', 27–45 µm long, 28–34 µm in diameter, middle wall smooth walled and golden; 'sporangial cell wall sometimes with an arrested gametangial tube' (Skinner 1983, 226).

Taxonomic Assessment: *Spirogyra mirabilis* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 70-200 µm long, (18–)21–33 µm in diameter, with plane end-walls; chloroplast single, making 4–7 turns; reproduction by aplanospores or very rarely by scalariform conjugation, conjugation tubes formed equally by both gametangia, sporangia enlarged or inflated; aplanospores and zygospores ovoid, less frequently ellipsoid, (33–)50–83(–88) µm long, 23–29(–45) µm in diameter, middle wall smooth and yellow-brown. The report by Skinner is consistent with this description and his records are therefore accepted as *S. mirabilis*. However, the vegetative cells described by Playfair (1918) are longer and slightly narrower than those reported generally for *S. mirabilis* and his description could apply equally to other species such as *S. fennica*; this record is not accepted here.

27. Spirogyra moebii Transeau, *Trans. Amer. Microscop. Soc.* 53: 225 (1934). *Spirogyra maxima* var. *minor* Moebius, *Abh. Senckenberg. Naturf. Ges.* 18: 334 (1895).

Known Distribution: North America, Brazil, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: Dalby, Darling Downs, *T.L. Bancroft*, v.1893 (Moebius 1895, Bailey 1895, 1913; all as *Spirogyra maxima* var. *minor*; Grimes 1988); Canungra and Mt Alford, *J.A. McLeod*, [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells 160–240 µm long, 78–80 µm in diameter, 2–3 times as long as broad, end-walls plane; chloroplasts 6–8, making 0.5–1 turn; gametangia not swollen, shorter than vegetative cells; conjugation scalariform, conjugation tubes formed equally by both gametangia; zygospores lenticular, c. 80 µm in diameter, middle wall golden-brown.

Taxonomic Assessment: *Spirogyra moebii* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984) by vegetative cells 130–240 µm long, 77–118 µm in diameter, with plane end-walls; chloroplasts 6–8, making 0.5–1 turn; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical; zygospores lenticular, 70–103 µm long, 50–75 µm in diameter, middle wall reticulate and yellow-brown. The change of rank for this taxon has been accepted by all authors cited above, and as the type is from Australia the species is accepted here.

28. Spirogyra neglecta (Hassall) Kütz., *Sp. alg.* 441 (1849). *Zygnema neglectum* Hassall, *Hist. Brit. Freshwater Alg.* 142, pl. 23 fig. 1, 2 (1845).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimen Reported: NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1916-1918 (Playfair 1918).

Description of Australian Specimens: Vegetative cells 50–360 µm long, 46–64 µm in diameter, end-walls plane; chloroplasts 3–5, each with a central ridge, making 1–3 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical or inflated. 46–57 µm in diameter; zygospores ovoid to elliptical, 52–91 µm long, 42–51 µm in diameter.

Taxonomic Assessment: *Spirogyra neglecta* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Dias 1992; Kargupta and Sarma 1992) by vegetative cells 100–300 µm long, (50–)55–67 µm in diameter, with plane end-walls; chloroplasts 3, making 1–2.5 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia; gametangia inflated, zygospores and aplanospores ovoid, sometimes orientated at right angles to the filament, 75–100 µm long, 54–64 µm in diameter, middle wall smooth and yellow. Although the dimensions of the Australian material are slightly different to those reported generally for *S. neglecta*, Playfair's taxon is more like *S. neglecta* than any other described species. Playfair (1918) described a number of variants of this species. The description above is based on the combined data from all these except *Spirogyra neglecta* var. *amylacea* which is now referred to *S. columbiana*.

29. Spirogyra nitida (Dillwyn) Link, *Handbuch* 3: 262 (1883). *Conferva nitida* Dillwyn, *Brit. Confery*. 4: 49 (1809); *Spirogyra princeps* (Vaucher) Cleve, *Fors. Svenska Zygnuem*. 16, pl. 1 figs 4-7 (1868), equated with *Spirogyra nitida* by De Toni (1889).

Known Distribution: North America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: NORTHERN TERRITORY: Standly Chasm, MacDonnell Range, *J.H. Simmonds*, 1.vi.1978 (Cribb 1983). QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1895; Bailey 1895, 1913; Pigram 1909); Gympie and Isis, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917). VICTORIA: Botanic Gardens lake, *A.D. Hardy*, 12.v.1906 (Hardy 1906); Gippsland (Kützing 1882b); [s. loc.] (Kützing 1882b, as '*Sirogonium princeps*' (presumably = *Spirogyra princeps*)).

Specimen Examined: QUEENSLAND: Shallow pool, Botanic Gardens, Brisbane, *G.E. Burrows*, 30.v.1976 (BRI).

Description of Australian Specimens: Vegetative cells 60–65 µm in diameter, 5–6 times as long as broad, end-walls plane; chloroplasts 4, making 2 turns; gametangia slightly swollen and somewhat shorter than vegetative cells; zygospores ovoid with attenuated ends, 90–117 µm long, 55–65 µm in diameter; outer wall thick, colourless, middle wall thin, smooth and chestnut-brown (published data).

Vegetative cells 60–120 µm long, 75–90 µm in diameter, end-walls plane; chloroplasts 2, making 1.5(–2) turns; conjugation lateral (sometimes possibly scalariform), gametangia enlarged; immature zygospores globose, 48–72 µm long, 75–78 µm in diameter (from the specimen at BRI).

Taxonomic Assessment: *Spirogyra nitida* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 90–300 µm long, (60–)70–90(–110) µm in diameter, with plane end-walls; chloroplasts 3–5, making 0.5–1.5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia, vegetative cells of conjugating filaments not swollen, gametangia cylindrical or enlarged; zygospores ellipsoid or slightly ovoid, (73–)90–177 µm long, (50–)60–89 µm in diameter, middle wall thick, smooth and brown. Cell dimensions vary slightly between Moebius's (1895) report and this description, but the illustrations showing the sometimes attenuated spores are a good match. Moebius (1895; translated in Bailey 1895, 34) notes the specimen matches the diagnosis of *S. nitida* but 'the spores are not yellowish (flavescentes) but chestnut-brown'. The description by McLeod (1975) is also consistent with *S. nitida* as described here. The herbarium material examined, however, has too few chloroplasts along with lateral conjugation. In the absence of mature spores it cannot be identified to species. The other reports lack documentation and also cannot be verified.

30. Spirogyra porticalis (O.F. Müll.) Cleve, *Nova Acta Regiae Soc. Sci. 7 Upsal.* Ser. 3, 6: 22, pl. 5 fig. 8-9 (1868). *Conferva porticalis* O.F. Müll., *Nova Acta Acad. Sci. Imp. Petrop. Hist. Acad.* pars 3: 90 (1785); *Zygnema porticalis sensu* Watts, *Victorian Naturalist* 1: 21 (1884); *Zygnema quininum* C. Agardh, *Syst. Alg.* 80 (1824).

Known Distribution: North and South America, Europe, North Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Lake Broadwater, *J.A. Grimes*, xi.1986 (Grimes 1988); Freestone, Warwick, [s. d.](Pigram 1909); Bell and Walsh River, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917). VICTORIA: swamp at Ballarat (Watts 1865, as '*Zygnema quininum* '[presumably misspelt *Z. quininum*]; Yan Yean Reservoir, *G.S. West*, x.1905 (Hardy 1906; West 1909).

Description of Australian Specimens: Vegetative cells 3 times as long as broad, end-walls plane; chloroplast single, making 3–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia slightly swollen; zygospores ovoid, outer wall smooth, middle wall smooth. (calculated from illustration in Pigram 1909).

Taxonomic Assessment: *Spirogyra porticalis* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Kargupta and Sarma 1992) by vegetative cells 66–200 µm long, 40–55 µm in diameter, with plane end-walls; chloroplast single, making 2.5–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; vegetative cells of conjugating filament not swollen, gametangia cylindrical or slightly enlarged; zygospores mostly ovoid to globose-ovoid, (42–)50–83 µm long, (33–)35–54 µm in diameter, middle wall smooth and yellow. Pigram (1909) was unsure as to whether his collection should be referred to *S. quinina* Kütz. or *S. porticalis*. De Toni (1889) and Borge (1913) consider both names to be synonymous (*S. porticalis* the earlier of the two) while later authors have kept the taxa apart. In any case, Pigram's (1909) description is concordant with the above description of *S. porticalis*. The illustration in Grimes (1988) matches the illustrations published elsewhere with the exception of the zygospore being slightly ovoid or even acuminate at one end. Despite published descriptions stating that the zygospores are ovoid only those Kargupta and Sarma (1992) show any zygospores of this shape. Nevertheless, the collection by Grimes is accepted as *S. porticalis* as is the McLeod (1975) collection. There is not enough information to confidently identify the other Australian collections (including Watts's undocumented report of *S. quinina* which is referred here).

31. Spirogyra protecta H.C. Wood, *Contr. Freshwat. Alg. N. Amer.* 19: 165, t. 14 fig. 3 (1872). *Spirogyra calospora* Czurda, *Süsswasserflora* 9: 147 (1932).

Known Distribution: North America, Europe, Africa, Australia.

Specimens Reported: QUEENSLAND: Caboolture River, *T.L. Bancroft*, v.1893 (Moebius 1892; Bailey 1893, 1913; Pigram 1909; all as *S. calospora*).

Description of Australian Specimens: Vegetative cells c. 27 µm in diameter, 5–8 times as long as broad, end-walls replicate; chloroplasts making 4–5 turns; gametangia somewhat turgid, shorter than vegetative cells; zygospores elliptical, 64–70 µm long, 30–36 µm in diameter, middle wall brown, scrobiculate, in optical section appearing streaked with fine striations.

Taxonomic Assessment: *Spirogyra protecta* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 120–425 µm long, 27–42 µm in diameter, with end-walls replicate; chloroplasts 1(–2), making 2–7 turns; conjugation scalariform,

conjugation tubes formed equally by both gametangia, gametangia cylindrical or enlarged; zygospores ellipsoid to cylindrical-ellipsoid, 66–90 µm long, 30–38(–50) µm in diameter, outer wall of 2 layers of which the inner is thick and scrobiculate the outer smooth and colourless, middle wall yellow, smooth; aplanospores similar to zygospores but smaller. Although the descriptions of *S. protecta* seem to vary between authors, the Australian collection fits within their combined ranges and the name is accepted in our census.

32. Spirogyra punctata Cleve var. **tenuior** Moebius, *Flora* 75: 438 (1892).

Known Distribution: Australia.

Specimen Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Bailey 1893, 1913; Moebius 1892).

Description of Australian Specimens: Vegetative cells 18–20 µm in diameter, 3–5(–8) times as long as broad, chloroplast single, making 3–5 turns; conjugation tubes formed by the male gametangia; zygospores 60–70 µm long, 33–32 µm in diameter, middle wall punctate.

Taxonomic Assessment: *Spirogyra punctata* is described by Borge (1913), Dillard (1990), Gauthier-Liévre (1965), Kadłubowska (1984) and Randhawa (1959). *Spirogyra punctata* thus far known only from the type collection, differs from the taxon described in these publications (and presumably characterizing the typical variety) by smaller vegetative cells and zygospore dimensions.

33. Spirogyra rivularis (Hassall) Rabenh., *Fl. Eur. Alg.* 3: 243 (1868). *Zygnema rivulare* Hassall, *Ann. Mag. Nat. Hist.* 10: 38 (1842).

Known Distribution: North America, Europe, South Africa, Asia, Papua New Guinea, Australia.

Specimens Reported: QUEENSLAND: Burpengary, *T.L. Bancroft*, iii.1893 (Bailey 1895, 1913; Moebius 1895); [s. loc] *F. Pigram*, [s. d.] (Pigram 1909); Toorbul Point and King John Creek, *J.A. McLeod*, [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells 30–38 µm in diameter, 4–15 times as long as broad, end-walls plane; chloroplasts 2, making 0–4 turns, conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia 2–3 times as long as broad, not inflated; zygospores elliptical to ovoid, 50–65 µm long, 20–34 µm in diameter.

Taxonomic Assessment: *Spirogyra rivularis* var. *rivularis* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 100–400 µm long, 36–41 µm in diameter, with plane end-walls; chloroplasts 2–3, making 2.5–3.5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia shortened, cylindrical or enlarged; zygospores ellipsoid, 60–100 µm long, 35–42 µm in diameter, middle wall smooth and yellow or brownish-yellow. Moebius (1895, 335) notes that 'the dimensions here specified do not agree in all respects with those of the typical species' and suggested that it could be var. *minor* Hansg. According to De Toni (1889), *S. rivularis* var. *minor* Hansg. has vegetative cells 24–0 µm in diameter and 3 times as long. Some Australian collections do not fall comfortably within either variety, but all Australian reports are accepted as *S. rivularis*. This species cannot be distinguished from *S. decimina* in the vegetative condition.

34. Spirogyra singularis Nordst., *Bot. Not.* 118 (1880). *Spirogyra silvicola* M.E. Britton, *Amer. J. Bot.* 30: 799, fig. 1 (1943).

Known Distribution: North and South America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Examined: QUEENSLAND: Sandgate Lagoon and Ashgrove Creek, *J.A. McLeod*, [s. d.] (McLeod 1975). SOUTH AUSTRALIA: Dickerees Lagoon, Birdsville Track, *J.W. Cribb*, 23.viii.1978 (BRI; Cribb 1983 as *S. silvicola*).

Description of Australian Specimens: Vegetative cells 105–110 µm long, c. 39 µm in diameter, end-walls plane; chloroplast single; conjugation tubes formed equally by both gametangia; gametangia cylindrical; zygospores elongate-ellipsoid, 55–90(–126) µm long, 33–42 µm in diameter, middle wall yellow-brown with green.

Taxonomic Assessment: Transeau (1951, 151) noted that the vegetative filaments of *S. silvicola* are 'similar to those of *S. singularis*' but the zygospores are larger. More recently, Dillard (1990) and Kadłubowska (1972, 1984) considered *S. silvicola* to be a synonym of *S. singularis*. *Spirogyra singularis* is characterized (Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 60–240 µm long, 29–42 µm in diameter, with plane end-walls; chloroplast single, making 3–7 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia not swollen; zygospores ellipsoid, 46–103 µm long, 27–43 µm in diameter, middle wall thickened, smooth and yellow or brown. The spores examined from the Australian material were elongate, matching the illustrations of *S. silvicola* in Transeau (1951), and all other features are consistent with the above description. The description provided by McLeod (1975) is also consistent with this data. The name *S. singularis* is therefore accepted for Australia. This species is similar to *S. longata*.

35. Spirogyra submaxima Transeau, *Amer. J. Bot.* 1: 295, pl. 27 figs 3-4 (1914).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimens Reported: NEW SOUTH WALES: Gwydir River, Bundarra, *Schneider*, iii.1974 (Skinner 1980); Aberfoyle River, *S. Skinner*, iii.1974 (Skinner 1980); Falconers Creek, Guyra, *S. Skinner*, xii.1974 (Skinner 1980); Mother of Ducks Lagoon, Guyra, *S. Skinner*, xii.1974 (Skinner 1980). VICTORIA: Yarra River basin, *T.J. Entwisle 1316*, 2.vii.1987 (Entwisle 1989).

Description of Australian Specimens: Vegetative cells 110–280 µm long, 68–120 µm in diameter, end-walls plane; chloroplasts 7–10, making 1–2 turns; conjugation scalariform (involving entire filament), conjugation tubes formed equally by both gametangia; gametangia inflated; zygospores lenticular to slightly ovoid lenticular (56–)72–115 µm in diameter, 52–55 µm thick, middle wall smooth and golden-brown.

Taxonomic Assessment: *Spirogyra submaxima* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kad-lubowska 1972, 1984; Dillard 1990; Kargupta and Sarma 1992; Habib 1993) by vegetative cells 100–300 µm long, 70–110 µm in diameter, with plane end-walls; chloroplasts 8–9, making 0.1–1 turn; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical, or inflated; zygospores and aplanospores lenticular, (58–)70–110 µm long, 50–75µm in diameter, middle wall smooth and brown. The Australian reports all match this description and the name *S. submaxima* is accepted for Australia.

36. Spirogyra tenuissima (Hassall) Kütz., *Sp. alg.* 437 (1849). *Zygnema tenuissimum* Hassall, *Hist. Brit. Freshwater Alg.* 152, pl. 32 fig. 9, 10 (1845).

Known Distribution: North and South America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: [s. loc.] *F. Pigram* [s. d.] (Pigram 1909); Ithaca, *J.A. McLeod*, [s. d.] (McLeod 1975). VICTORIA: Yarra Glen, *A.D. Hardy*, 1906 (Hardy 1906).

Description of Australian Specimens: Vegetative cells 6–8 times as long as broad, end-walls replicate; conjugation scalariform and lateral; gametangia inflated; zygospores elliptical, (calculated from illustration in Pigram 1909).

Taxonomic Assessment: *Spirogyra tenuissima* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 40–250 µm long, 8–15 µm in diameter, with replicate end-walls; chloroplast single, making 3–6 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia; gametangia greatly inflated or enlarged toward the middle; zygospores and aplanospores ellipsoid, 40–74 µm long, 22–36 µm in diameter, middle wall smooth and yellow. The illustration in Pigram (1909) matches published descriptions of *S. tenuissima* but without filament and zygospore dimensions the collections could also be *S. inflata, S. rugosa* or *S. discreta*. Hardy (1906) provides no documentation for his record. The description in McLeod (1975), however, matches closely *S. tenuissima* and this record is accepted.

37. Spirogyra teodoresci Transeau, *Ohio J. Sci.* 34: 420 (1934). *Spirogyra varians* var. *minor* Teodor., *Beih. Bot. Centralbl.* 21, abt. 2 (1907).

Known Distribution: North and South America, Europe, Asia, Australia.

Specimen Examined: QUEENSLAND: Running Creek, *A.B. Cribb 1185.6*, 30.iii.1991 (BRI; Cribb 1991).

Description of Australian Specimens: Filaments attached by rhizoidal extension of basal cell; vegetative cells 20–90 µm long, 27.5–35 µm diameter, 0.5–2.2 times as long as broad, end-walls plane; chloroplast making single, 1.5–4 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia inflated on conjugating side only or sometimes slightly also on opposite side; zygospores ellipsoid mostly with long axis parallel to long axis of filament (only oblique or transverse in relatively short gametangia), 37–55 µm long, 25–35 µm diameter, 1.4–1.7 times as long as broad, middle wall smooth and yellow-brown.

Taxonomic Assessment: *Spirogyra teodoresci* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 42–90 µm long, 24–30 µm in diameter, with plane end-walls; chloroplast single, making 1–6 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia; gametangia strongly inflated on the conjugating side; zygospores ellipsoid, 45–55 µm long, 26–33 µm in diameter, middle wall smooth and yellow. The Australian report matches closely this description. Although also very similar to *S. varians*, the Cribb collection is slightly smaller in most features, and is therefore retained under the name *S. teodoresci*.

38. Spirogyra transeauiana C.C. Jao, *Sinensia* 6: 610, pl. 10 fig. 107 (1935).

Known Distribution: Asia, Australia.

Specimen Examined: SOUTH AUSTRALIA: Noarlunga Ford, Onkaparinka River, *D.P. Thomas and S. Skinner*, 14.x.1977.

Description of Australian Specimens: Vegetative cells 25–40 µm in diameter, end-walls replicate; chloroplasts 1–2, making about 4 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia enlarged on the conjugating side; zygospores ellipsoid, c. 100 µm long, 50–55 µm in diameter, green-gold to golden-brown.

Taxonomic Assessment: *Spirogyra transeauiana* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984) by vegetative cells 160–304 µm long, 42–61 µm in diameter, with replicate end-walls; chloroplasts 2–3, making 2–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia cylindrical or slightly enlarged on the conjugating side; zygospores

ellipsoid with rounded ends, 96–138 µm long, 41–58 µm in diameter, middle wall smooth and yellow. Although the Australian material has thinner vegetative filaments than generally reported for *S. trauseauiana* it matches this species more closely than any other species.

39. Spirogyra varians (Hassall) Kütz., *Sp. alg.* 439 (1849). *Zygnema varians* Hassall, *Hist. Brit. Freshwater Alg.* 145, pl. 29 figs 1-4 (1845).

Known Distribution: North and South America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Bardon and Mt. Alford, *J.A. McLeod*, [s. d.] (McLeod 1975). VICTORIA: Yarra River Basin, *T.J. Entwisle 1048, 1034, 1347*, 2.vii.1987 (Entwisle 1989, 1990).

Description of Australian Specimens: Filaments sometimes attached by rhizoidal extensions; vegetative cells 16–72 µm long, 32–45 µm in diameter, 0.5–2.0 times as long as broad, sometimes swollen end-walls plane; chloroplast single; conjugation scalariform, conjugation tubes formed equally by both gametangia; female gametangia usually inflated on conjugating side; zygospores ellipsoid, 44–52 µm long, 28–32 µm in diameter, 1.2–1.8 times as long as broad, middle wall smooth and yellow.

Taxonomic Assessment: *Spirogyra varians* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 30–120 µm long, 29–40 µm in diameter, with plane end-walls; chloroplast single, making 1–5 turns; conjugation scalariform and lateral, conjugation tubes formed equally by both gametangia; gametangia usually inflated on the conjugating side only, rarely on both sides, some of the sterile cells usually inflated, zygospores mostly ellipsoid, usually some of them ovoid and very rarely globose, (36–)50–100 µm long, (24–)32–40 µm in diameter, middle wall smooth and yellow; aplanospores similar to the zygospores. The Victorian collection differs in only minor ways from this description and this record is accepted. The description in McLeod (1975) matches closely *S. varians* and is clearly based on her own description and observations. This species is similar to *S. teodoresci.*

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Vegetative cells with stellate or disc-shaped chloroplasts; zygote separated from gametangia by special walls; gametangia not filled with pectic cellulose-colloid and without cytoplasmic residues.

40. Zygnema binuclearioides Cribb, *Queensland Naturalist* 21: 8 (1974).

Specimens Reported: QUEENSLAND: Lake Birrabeen, Fraser Island, *A.B. Cribb*, 15.viii.1971 (Cribb 1974); Peregian and Coolum, *J.A. McLeod*, [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells (22–)25–32(–35) µm in diameter, end-walls up to 120 µm thick; chloroplasts sometimes with 2 pyrenoids (in one or both chloroplasts); gametangia somewhat inflated; zygospores ellipsoid to cylindrical-ellipsoid, (17–)20–40(–42) µm long, (17–)20–25(–30) µm diameter, (1–)1.3–1.7(–1.9) times as long as broad; akinetes ellipsoid to cymbiform-ellipsoid.

Taxonomic Assessment: *Zygnema binuclearioides* is known from the type collection and two other collections by McLeod (1975). However, the description by McLeod seems to be taken from the protologue and only the type collection is accepted here as representing the species. *Zygnema binuclearioides* is accepted in Australia and is included in our census. It resembles the genus *Binuclearia* Wittr in vegetative morphology.

41. Zygnema carterae Czurda, *Süsswasserflora* 9: 114 (1932).

Known Distribution: New Caledonia, Australia.

Specimen Reported: SOUTH AUSTRALIA: Hacks Lagoon Cons. Pk, *L. Lloyd*, 15.ix.1982 (Skinner 1983).

Description of Australian Specimens: Vegetative cells (10–)12–16(–18) µm in diameter, 6–10(–12) times as long as broad, end-walls lenticular; conjugation scalariform; conjugation tube incomplete, zygospores held in mucilage between gametangial cells; zygospores spherical, 26–30 µm in diameter, middle wall scrobiculate, pale golden.

Taxonomic Assessment: *Zygnema carterae* is characterized (Czurda 1932; Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984) by vegetative cells (48–)64–128 µm long, 13–16 µm in diameter; conjugation lateral or scalariform; zygospores formed in the conjugating tubes, globose, 30–35 µm in diameter, middle wall scrobiculate and brown. No published illustrations of *Z. carterae* were found and Skinner (1983) states that his collection does not key out perfectly. According to Skinner (*in sched.*, AD *53989*) it 'differed from the type description ... in having only scalariform conjugation and a "halo" of mucilage rather than a closed gametangial tube.' Nevertheless, it matches *Z. carterae* more closely than any other published species.

42. Zygnema coeruleum Czurda, *Süsswasserflora* 9: 107, fig. 107 (1932).

Known Distribution: North America, Europe, South Africa, India, Australia.

Specimen Reported: NEW SOUTH WALES: Major Creek, Howell near Tinga, *Garrard*, vii.1974 (Skinner 1980).

Specimen Examined: QUEENSLAND: Jardine River, Cape York Peninsula, *A.B. Cribb 1038.12*, 27.viii.1985 (BRI; Cribb 1987).

Description of Australian Specimens: Vegetative cells 18–25 µm diameter, 3–4 times as long as broad, end-walls plane; conjugation scalariform; zygospores in conjugation tube, bulging into gametangia, globose to ellipsoid, 30–42.5 µm in diameter, 1–1.3 times as long as broad, middle wall yellow-brown to slate blue, 2–3 µm thick, lamellate, its outer part scrobiculate, with pits 1.5–2 µm diameter, 2–3 µm apart.

Taxonomic Assessment: *Zygnema coeruleum* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 40–55 µm long, (20–)24–26 µm in diameter; chloroplasts with rounded conspicuous pyrenoids; conjugation scalariform; zygospores formed in the conjugating tubes, ovoid to globose, 32–35 µm long, 26–32 µm in diameter, middle wall thick, scrobiculate and blue, pits c. 1.5 µm in diameter, c.3 µm apart. The Australian collections match closely this description and the name *Z. coeruleum* is accepted for Australia.

43. Zygnema cruciatum (Vaucher) C. Agardh, *Syn. Alg. Scand.* 102 (1817).

Conjugata cruciata Vaucher, *Hist. Conferv. Eau Douce* p. 76, fig. 2 (1803); *Tyndaridea cruciata* (Vaucher) Hassall, *Hist. Brit. Freshwater Alg.* 160, t. 38 fig. 1 (1845); *Zygnema dillwynii* Kütz., *Tab. Phycol.* 5: t. 17 (1855).

Known Distribution: North and South America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Ipswich, *J.A. McLeod*, [s. d.] (McLeod 1975). SOUTH AUSTRALIA: [s. loc., s. d.] (Sonder 1881; as *Z. dillwynii*). QUEENSLAND: Dalby, Darling Downs, *T.L. Bancroft*, v.1893 (Moebius 1895, Bailey 1895, 1913). NEW SOUTH WALES: Lismore, *G.I. Playfair*, 1914 (Playfair 1917). VICTORIA: Meredith, ?*Kützing*, 1882 (Kützing 1882b). TASMANIA: South Esk River, *Gunn*, 1860 (Harvey 1860, as *Tyndaridea cruciata*; Sonder 1881).

Specimen Examined: QUEENSLAND: Dry Creek, Kroombit Tops, *A.B. Cribb 990.1*, 14.xii.1983 (BRI; Cribb 1986).

Description of Australian Specimens: Vegetative cells 15–38 µm long, 30–40 µm in diameter; receptive gametangia somewhat or not enlarged on the conjugating side; zygospores spherical, 28–32 µm long, 28–35 µm in diameter, almost filling the cell, middle wall scrobiculate and yellow-brown, with pits 1.5–3 µm diameter, 1 µm apart to almost continuous.

Taxonomic Assessment: *Zygnema cruciatum* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 30–60 µm long, 30–39 µm in diameter; conjugation scalariform; gametangia cylindrical or enlarged; zygospores in one of the gametangia, globose to ovoid, 32–40 µm long, 30–38 µm in diameter, middle wall scrobiculate and brown, pits 1.5–2 µm in diameter, 3–5 µm apart; aplanospores cylindrical-ovoid, 30–60 µm long, 30–35 in diameter, filling the vegetative cells, otherwise similar to the zygospores. The Cribb collection matches this description in most respects except, as Cribb (1986) noted, the pits in the middle wall are more similar to *Z. calosporum*. That species, however, has smaller vegetative cells and *Z. cruciatum* seems more appropriate. The description in McLeod (1975) matches closely *Z. cruciatum* but we cannot be sure of its source. Without further documentation, the earlier reports (Bailey 1895, 1913; Harvey 1860; Kützing 1882b; Moebius 1895; Playfair 1917; Sonder 1881) cannot be assessed.

44. Zygnema insigne (Hassall) Kütz., *Sp. alg.* 444 (1849). *Conjugata insigne* Hassall, *Hist. Brit. Freshwater Alg.* 440, t. 103 figs 1–2 (1845).

Known Distribution: North and South America, Europe, Africa, Asia, Australia.

Specimens Reported: QUEENSLAND: Port Curtis district, *T.L. Bancroft*, v–vi.1892 (Moebius 1895; Bailey 1895, 1913). VICTORIA: Box Hill, *A.D. Hardy*, 12.v.1906 (Hardy 1906); [s. loc.] (Watts 1887).

Description of Australian Specimens: Filaments with a thick gelatinous covering as thick as the filament proper, vegetative cells 27–28 µm in diameter, 1.5–2 times as long as broad; zygospores globular, 27–30 µm in diameter.

Taxonomic Assessment: *Zygnema insigne* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 26–60 µm long, 26–32 µm in diameter; conjugation scalariform or lateral; female gametangia slightly, if at all, swollen; zygospores globose or subglobose, 27–35 µm long, 26–33 µm in diameter, middle wall thickened, smooth and yellow-brown; aplanospores 28–33 µm, ovoid to cylindrical-ovoid, otherwise similar to zygotes. The Queensland report matches this description and the name *Z. insigne* is accepted for Australia. The Victorian records cannot be confirmed as they include no documentation.

45. Zygnema melanosporum Lagerh., *Bot. Zentralbl.* 18: 279 (1884).

Known Distribution: North America, Europe, North Africa, India, Australia.

Specimen Reported: QUEENSLAND: Stanthorpe district, Girraween National Park and Bald Rock Creek, *A.B. Cribb*, 1-4.iv.1994 (Cribb 1994).

Description of Australian Specimens: Vegetative cells (30–)50–106 µm long, 22–27 µm in diameter, 1.3–4.5 times as long as broad; conjugation scalariform, female gametangia not or only slightly enlarged; zygospores globose, ellipsoid, ovoid or cylindrical-ellipsoid, 26–40 µm long, 20–35 µm in diameter, 1–1.6 (–2) times as long as broad, middle wall blue-black, with fine pits approximately 1 µm in diameter, 3–4 µm apart.

Taxonomic Assessment: *Zygnema melanosporum* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965) by vegetative cells 36–100 µm long, 22–27 µm in diameter; conjugation scalariform; female gametangia cylindrical or slightly enlarged; zygospores ovoid to cylindrical-ovoid, 28–36 µm long, 23–30 µm in diameter, middle wall finely punctate and dark blue. Although Cribb (1994) notes that a voucher was deposited at Queensland Herbarium (BRI) it was not sent as part of our loan. In any case, the description by Cribb (1994) matches the description except for extending some ranges, and the name *Z. melanosporum* is accepted in Australia.

46. Zygnema oveidanum Transeau, *Trans. Amer. Microscop. Soc.* 53: 208, pl. 17 fig. 1 (1934).

Known Distribution: North America, Australia.

Specimen Examined: QUEENSLAND: Rainbow Creek, Blackdown Tableland, *A.B Cribb 800.1*, 2.ix.1974 (BRI; Cribb 1976).

Description of Australian Specimens: Vegetative cells 24–66.5 µm long, 7.5–11.5 µm in diameter; conjugation tube inflated; zygospores globose, 21–27 µm in diameter, middle wall golden.

Taxonomic Assessment: *Zygnema oveidanum* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells (32–)35–40(–68) µm long, 8–12 µm in diameter; conjugation scalariform; zygospores formed in the conjugating tubes, ovoid to globose, 15–30 µm long, 12–15 µm in diameter, middle wall punctate, colourless to yellow, with pits about 1 µm in diameter. The Australian collection is consistent with the description and *Z. oveidanum* is accepted in our census.

47. Zygnema pectinatum (Vaucher) C. Agardh, *Syn. Alg. Scand.* 102 (1817). *Conjugata pectinata* Vaucher, *Hist. Conferv. Eau Douce* 77, fig. 4 (1803); *Zygogonium pectinatum* Kütz., *Sp. alg.* 447 (1849); *Tyndaridea lutescens* Hassall, *Hist. Brit. Freshwater Alg.* t. 38 fig. 4 (1845). Equated with *Zygnema pectinatum* by De Toni (1889).

Known Distribution: North and South America, Europe, Asia, New Zealand, Australia.

Specimens Reported: NORTHERN TERRITORY: Alligator River Region, Umbungbung Billabong, *H.U. Ling and P.A. Tyler*, 30.v.1979 (Ling and Tyler 1986). QUEENSLAND: University Lake, St Lucia and Sandgate Lagoon, Stradbroke Island, *J.A. McLeod*, [s. d.] (McLeod 1975); Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1892; Bailey 1893, 1913). NEW SOUTH WALES: Lismore, swamp on Woodlawn Road, *G.I. Playfair*, 1914 (Playfair 1915, 1917). VICTORIA: swamp at Ballarat and Lake Wangoon at Warrnambool (Watts 1865, as *Tyndaridea lutescens*); [s. loc.] (Kützing 1882b, as *Zygogonium pectinatum*).

Description of Australian Specimens: Vegetative cells 42–70 µm long; 20–33 µm in diameter, constricted at the end-walls and swollen in the middle; zygospores formed in the tube, globose, 43–46 µm long, 33–37 µm in diameter, middle wall pitted and brown.

Taxonomic Assessment: *Zygnema pectinatum* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 25–120 µm long, 30–36 µm in diameter; conjugation scalariform, rarely lateral; zygospores formed in the conjugation tube, globose to ellipsoid, 40–70 µm long, 33–60 µm in diameter, middle wall scrobiculate and brown, pits about 2–4 µm in diameter; aplanospores ovoid or cylindrical, 30–60 µm long, 30–38 µm in diameter, wall similar to that of the zygospore. The non-Victorian collections match the current literature and can therefore be retained under the name *Z. pectinatum*. The Kützing (1882b) and Watts (1865) reports include no documentation and cannot be assessed.

48. Zygnema spontaneum Nordst., *Alg. Ag. Dulc. Sandvic.* 17, pl. 1 figs 23–4 (1878).

Known Distribution: Hawaii, North America, Africa, Asia, Australia.

Specimen Reported: VICTORIA: Yan Yean Reservoir, *G.S. West*, xi–xii.1905–i.1906 (West 1909).

Description of Australian Specimens: Vegetative cells 15–17 µm in diameter; conjugation scalariform, conjugation tubes very wide; female gametangia inflated; zygospores projecting into conjugation tubes, 29–34 µm in diameter; aplanospore c. 20 µm in diameter.

Taxonomic Assessment: *Zygnema spontaneum* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 28–90 µm long, 14–22 µm in diameter; conjugation scalariform, female gametangia only slightly, if at all, swollen on the conjugating side; zygospores globose (sometimes irregular), 21–36 µm long, 18–25 µm in diameter, extending into the conjugation tube, middle wall thickened, scrobiculate and yellow to yellow-brown, pits about 2 µm in diameter, 3–5 µm apart; aplanospores often produced, ovoid to cylindrical-ovoid, 18–23 µm long, 16–22 µm in diameter, otherwise as zygospore. Gauthier-Liévre (1965), Transeau (1951), Randhawa (1959) report reproduction by aplanospores only. Some of the descriptions are clearly based on the description of West (1909, 52) who noted that the 'zygospores exhibited a considerable degree of variation in form and position... [and] were of relatively greater diameter' than those observed from West Africa and Burma. The Australian material keys out to *Z. decussatum* in Randhawa (1959) and Transeau (1951) and is similar also to *Z. subtile*, *Z. tenue* and *Z. cylindricum*. However, it does match at least some monographic accounts of *Z. spontaneum* and this determination is accepted here.

ZYGOGONIUM Kütz.

Vegetative cells with cushion-shaped chloroplasts; zygospores in sporangia of 2 cup-like parts with a suture; cytoplasmic residue remaining in the gametangia

49. Zygogonium ericetorum Kütz., *Phycol. General.* 446 (1843). *Zygnema ericetorum* (Kütz.) Hansg., *Prodr. Algenfl. Böhmen* 155 (1886).

Known Distribution: America, Europe, Africa, Asia, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1892; Bailey 1893, 1913); Beerwah, *R.L. Specht*, 1979 (Specht 1979). VICTORIA: Haddon and Wimmera, *F. Mueller*, 1882 (Kützing 1882b); [s. loc.] (Sonder 1881). TASMANIA: [s. loc.] (Sonder 1881).

Specimens Examined: QUEENSLAND: Peregian, Toorbul Point, Pialba, Coomera Island, Elliot Heads, *J.A. McLeod*, [s. d.] (McLeod 1975); Bowen Creek, Hinchinbrook Island, *A.B. Cribb 894.37*, 25.viii.1979 (BRI); Tributary of Sanamere Lagoon, Cape York Peninsula, *A.B. Cribb 1043.4*, 3.ix.1985 (BRI; Cribb 1987); Jardine River, Cape York Peninsula, *A.B. Cribb 1044.1*, 4.ix.1985 (BRI; Cribb 1987); Mimosa Creek, Blackdown Tableland, *A.B. Cribb 804.1*, 11.ix.1974 (BRI; Cribb 1976); Rainbow Creek, Blackdown Tableland, *A.B. Cribb 800.14*, 2.ix.1974 (BRI; Cribb 1976); North branch of Mimosa Creek, Blackdown Tableland, *A.B. Cribb 802.7*, 4.ix.1974 (BRI; Cribb 1976); Under Rainbow Falls, Blackdown Tableland, *A.B. Cribb 800.17*, 2.ix.1974 (BRI; Cribb 1976); Jimna State Forest, *A.B. Cribb 793.6*, 16.xi.1974 (BRI); Cholmondeley Creek, Cape York Peninsula, *A.B. Cribb 1193.4*, 12.iii.1992 (BRI); Bertie Creek, Cape York Peninsula, *A.B. Cribb 1194.2*, 12.iii.1992 (BRI); Wyberba near Stanthorpe, *A.B. Cribb*, x.1968 (BRI). TASMANIA: Lake Dove, 13.xii.1973, *A.B. Cribb 773.1* [BRI *706049*].

Description of Australian Specimens: Vegetative cells 12–60 µm long, 15–45 µm in diameter, end-walls plane; conjugation rarely present, lateral; aplanospores, akinetes and zygospores oblong to globose, 30–54 µm long, 18–37 µm in diameter, middle wall smooth and pale yellow.

Taxonomic Assessment: *Zygogonium ericetorum* is characterized (Borge 1913 Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Devi and Panikkar 1992) by branched or unbranched filaments with vegetative cells 10–100 µm long, 12–33 µm in diameter, conjugation scalariform; zygospores with definite sporangia formed by the conjugating tubes and cut off by a wall from the adjoining gametangia, ovoid to ellipsoid, 15–40 µm long, 13–26 µm in diameter, middle wall thick, smooth and colourless to yellow-brown; aplanospores occupying only part of the cell, globose or ovoid, 15–40 µm long, 15–20 µm in diameter, middle wall smooth. Moebius (1892, 438) refers a collection with 'cells 18 µm thick, once to twice as long, at times with side sprays' to var. *terrestris* Kirchner. Almost all of the Australian specimens are sterile but the vegetative features are fairly distinctive and match the above description. The name *Z. ericetorum* is accepted in our census.

50. Zygogonium heydrichii (W. Schmidle) Transeau, *Ohio J. Sci.* 33: 159 (1933).

Zygnema heydrichii W. Schmidle, *Flora* 84: 167 (1897).

Known Distribution: Australia.

Specimen Reported: NEW SOUTH WALES: Quarantine Station in Sydney, *Lauterbach*, 1876 (Schmidle 1897).

Description of Australian Specimens: Vegetative cells 25–66 µm long, 14–20 µm in diameter, wall lamellate; conjugation lateral; zygospores formed in conjugating tube, ellipsoid, rarely globose or heart-shaped, c. 32 µm long, 24–28 µm in diameter, middle wall pitted and yellowish.

Taxonomic Assessment: Schmidle (1897) notes that the chloroplasts and other features were difficult to observe due to the poor quality of the material and he was unsure whether this species belonged to *Zygnema* or *Zygogonium*. The taxon is now referred to *Zygogonium*, and the name *Zygogonium heydrichii* is accepted here.

51. Zygogonium kumaoense Randhawa, *J. Indian Bot. Soc.* 19: 247 (1940).

Known Distribution: India, New Zealand, Australia.

Specimens Reported: QUEENSLAND: Peregian, *J.A. McLeod*, [s. d.] (McLeod 1975); Lake Birrabeen, Fraser Island, *A.B. Cribb*, viii.1971 (Cribb 1974).

Specimens Examined: QUEENSLAND: 'Heathlands', Cape York Peninsula, *A.B. Cribb 1212.2*, 23.iii.1992 (BRI); Ramsay Bay, Hinchinbrook Island, *A.B. Cribb 829.13*, 12.viii.1975 (BRI); Jardine River, Cape York Peninsula, *A.B. Cribb 1044.4*, 4.ix.1985 (BRI; Cribb 1987).

Description of Australian Specimens: Attachment filaments branched, cells irregular; vegetative cells cylindrical, 30–82 µm long, 5–21 µm diameter, 4–24 µm as long as broad, rhizoidal outgrowths occasional, knob-like to irregular; aplanospores not or only slightly distending the filament, borne in any part of the cell but commonly at one end, sometimes at the end of a rhizoid, subglobose to ellipsoid, 8.5–12.5 µm long, 7.5–8.5 (15–22) µm diameter, middle wall hyaline, unornamented.

Taxonomic Assessment: *Zygogonium kumaoense* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1984; Devi and Panikkar 1992) by vegetative filaments with irregular cells, 20–140 µm long, 9.5–14 µm in diameter, with rhizoids; conjugation scalariform; zygospores globose, 25–29 µm in diameter, middle wall thick, smooth, yellow; aplanospores globose to subglobose,

15–24 µm long, 12–17 µm in diameter, middle wall smooth and transparent. There is some difference of opinion over whether lateral conjugation sometimes occurs or whether such reports are of misinterpreted aplanospores. The Australian collections have smaller 'aplanospores' than are reported generally for *Z. kumaoense* but seem to match this species in all other respects. The name is therefore accepted here.

Key to Accepted Taxa

This key is based, as far as possible, on data from Australian reports and collections. Where there are discrepancies between the Australian reports and world monographs we have only used the latter to avoid blatant contradictions.

1. Vegetative cells with elongate chloroplasts extending the length of the cell.....2
1. Vegetative cells with stellate or disc-shaped chloroplasts.....45

2. Cells with 1 axial chloroplast.....3
2. Cells with 1-several parietal, spiral chloroplasts.....10

3. Vegetative filaments < 8 µm in diameter; zygote not separated from gametangia by special walls; cytoplasmic residue not left in the gametangia; sporangia filled with pectic cellulose-colloid.....**1. *Debarya hardyi***
3. Vegetative filaments usually > 8 µm in diameter; zygotes separated from gametangia by special walls; cytoplasmic residue left in the gametangia.....4

4. Zygospores H-shaped, middle wall lamellate.....**6. *Mougeotia sestertisignifera***
4. Zygospores not H-shaped, middle wall smooth.....5

5. Conjugation tubes enlarged.....6
5. Conjugation tubes not enlarged.....8

6. Vegetative filaments diameter less than 20 µm.....**4. *Mougeotia parvula* var. *parvula***
6. Vegetative filaments diameter more than 20 µm.....7

7. Vegetative filaments diameter 43–54 µm; zygospores 51–70 µm in diameter.....**2. *Mougeotia acadiana***
7. Vegetative filaments diameter 34–41 µm; zygospores 36–47(–60) in diameter.....**3. *Mougeotia laetevireus***

8. Sporangium surrounded by pectic material; zygospores less than 25 µm in diameter.....**8. *Mougeotia victorieusis***
8. Sporangium not surrounded by pectic material; zygospores more than 25 µm in diameter.....9

9. Zygospores less than 40 µm in diameter.....**5. *Mougeotia scalaris***
9. Zygospores more than 40 µm in diameter.....**7. *Mougeotia subcrassa***

10. Vegetative filaments more than 70 µm in diameter.....11
10. Vegetative filaments less than 70 µm in diameter.....17

11. Chloroplasts spiraled more than 2 times.....**16. *Spirogyra ellipsospora***
11. Chloroplasts spiraled 2 or fewer times.....12

12. Chloroplasts usually fewer than 6 per cell; vegetative filaments 60–80 µm in diameter.....13
12. Chloroplasts usually more than 6 per cell; vegetative filaments 70–140 µm in diameter.....14

13. Chloroplasts 5–6 per cell; zygospores 45–60 µm in diameter**11. *Spirogyra bellis***
13. Chloroplasts 3–5 per cell; zygospores 55–89 µm in diameter **29. *Spirogyra uitida***

14. Gametangia inflated.....**35. *Spirogyra subuaxiua***
14. Gametangia cylindrical.....15

15. Vegetative filaments 108–130(–140) µm in diameter.....**25. *Spirogyra maxiua***
15. Vegetative filaments 77–80(–118) µm in diameter.....**27. *Spirogyra uoebii***

16. Vegetative filaments 66–200 µm long, 40–55 µm in diameter; zygospores 54–54 µm in diameter ..... **30. *Spirogyra porticallis***
16. Combined characters not as above 17

17. Zygospores more than 40 µm in diameter 18
17. Zygospores less than 40 µm in diameter 26

18. Cell end-walls replicate 19
18. Cell end-walls plane 21

19. Gametangia enlarged on conjugation side only ..... **38. *Spirogyra transeauiana***
19. Gametangia inflated or enlarged equally on both sides 20

20. Conjugation tubes formed equally by both gametangia ..... **17. *Spirogyra farlowii***
20. Conjugation tubes formed largely by male gametangia ..... **20. *Spirogyra grevilleana***

21. Vegetative cell less than 46 µm in diameter 22
21. Vegetative cell more than 46 µm in diameter 23

22. Conjugation scalariform and lateral ..... **24. *Spirogyra lougata***
22. Conjugation only scalariform ..... **34. *Spirogyra singularis***

23. Gametangia cylindrical 24
23. Gametangia not cylindrical 25

24. Chloroplasts one per cell; zygospores 40–45 µm in diameter ..... **9. *Spirogyra australieusis***
24. Chloroplasts 1–3 per cell; zygospores 42–70 µm in diameter ..... **12. *Spirogyra columbiaua***

25. Chloroplasts 5 or more per cell ..... **11. *Spirogyra bellis***
25. Chloroplasts less than 5 per cell ..... **28. *Spirogyra ueglecta***

26. Cell end-walls replicate 27
26. Cell end-walls plane 33

27. Vegetative cells less than 23 µm in diameter 28
27. Vegetative cells more than 23 µm in diameter 31

28. Chloroplast spiraled 5–9 times per cell ..... **19. *Spirogyra frigida***
28. Chloroplast spiraled 2.5–6 times per cell 29

29. Conjugation tubes formed by male gametangia ..... **14. *Spirogyra cylindrica***
29. Conjugation tubes formed by both gametangia 30

30. Vegetative filaments more than 15 µm in diameter ..... **21. *Spirogyra iuflata***
30. Vegetative filaments less than 15 µm in diameter ..... **36. *Spirogyra tenuissiua***

31. Conjugation tubes formed largely by male gametangia. **20. *Spirogyra grevilleaua***
31. Conjugation tubes formed equally by both gametangia 32

32. Middle wall not scrobiculate ..... **17. *Spirogyra farlowii***
32. Middle wall scrobiculate ..... **31. *Spirogyra protecta***

33. Chloroplasts more than 1 per cell 35
33. Chloroplasts 1 per cell 37

34. Vegetative cells less than 24 µm in diameter ..... **10. *Spirogyra baileyi***
34. Vegetative cells more than 24 µm in diameter 35

35. Gametangia cylindrical; pyrenoids numerous ..... **22. *Spirogyra irregularis***
35. Gametangia shortened, cylindrical or enlarged; pyrenoid few 36

36. Vegetative filaments 60–150 µm long; zygospores 31–68 µm long ..... **15. *Spirogyra deciuiua***
36. Vegetative filaments 100–400 µm long; zygospores 50–100 µm long ..... **33. *Spirogyra rivularis***

37. Conjugation tubes formed by the male gametangia; zygospores middle wall punctate ..... **32. *Spirogyra punctata*** var. ***tenuior***
37. Conjugation tubes formed by both gametangia; zygospores middle wall not punctate 38

38. Gametangia cylindrical or occasionally slightly inflated 39
38. Gametangia always strongly inflated at least on one side 42

39. Zygospores about 18–26 µm in diameter ..... **13. *Spirogyra communis***
39. Zygospores more than 26 µm in diameter 40

40. Conjugation only scalariform; zygospores 55–90(–126) µm long ..... **34. Spirogyra *singularis***
40. Conjugation scalariform and lateral; zygospores less than 90 µm long 41

41. Zygospores always less than 3 times as long as broad ..... **23. *Spirogyra juergensis***
41. Zygospores 3–4 times as long as broad ..... **24. *Spirogyra longata***

42. Vegetative cells less than 21 µm in diameter ..... **18. *Spirogyra fennica***
42. Vegetative cells more than 21 µm in diameter 43

43. Reproduction by aplanospores (rarely by scalariform conjugation) ..... **26. *Spirogyra mirabilis***
43. Conjugation scalariform or lateral 44

44. Vegetative filaments 24–35 µm in diameter ..... **37. *Spirogyra teodoresci***
44. Vegetative filaments 29–45 µm in diameter ..... **39. *Spirogyra varians***

45. Chloroplasts cushion-shaped 46
45. Chloroplasts stellate 48

46. Reproduction by aplanospores only, spore wall transparent ..... **51. *Zygogonium kumaoense***
46. Reproduction by zygospores (sometimes aplanospores), spore yellow 47

47. Middle wall of spores smooth ..... **49. *Zygogonium ericetorum***
47. Middle wall of spores scrobiculate ..... **50. *Zygogonium heydrichii***

48. Cell cross-walls stratified, vegetatively resembling *Binuclearia* ..... **40. *Zygnema binuclearioides***
48. Cell cross-walls not thick or stratified 49

49. Middle walls of spores smooth ..... **44. *Zygnema insigne***
49. Middle walls of spores scrobiculate 50

50. Middle walls of spores blue 51
50. Middle walls of spores not blue 52

51. Zygospores formed in conjugation tube ..... **42. *Zygnema coeruleum***
51. Zygospores formed in one of the gametangia ..... **45. *Zygnema melanosporum***

52. Vegetative filaments less than 20 µm in diameter 53
52. Vegetative filaments more than 20 µm in diameter 55

53. Vegetative filaments less than 12 µm in diameter ..... **46. *Zygnema oveidanum***
53. Vegetative filaments more than 12 µm in diameter 54

54. Gametangia not inflated; zygospores formed entirely within conjugation tube ..... **41. *Zygnema carterae***
54. Gametangia inflated on the conjugation side; zygospores formed in gametangia and extending partly into conjugation tube ..... **48. *Zygnema spontaneum***

55. Zygospores less than 40 µm long ..... **43. *Zygnema cruciatum***
55. Zygospores more than 40 µm long ..... **47. *Zygnema pectinatum***

Rejected Taxa

The following names are excluded from the census. They were either reported without any supporting documentation or do not match protologues and monographic accounts; none are represented by adequate voucher material.

Mougeotia capucina (Bory) C. Agardh, *Syst. Alg.* 84 (1824). *Leda capucina* Bory, *Moug. et Nestl. Exs.* n. 793 [s. d.].

Known Distribution: Hawaii, North and South America, Europe, Central Africa, New Zealand.

Specimen Reported: TASMANIA: *C. Stuart*, 1852 (Sonder 1852, 1880).

Specimen Examined: NEW SOUTH WALES: Heathcote, Woronora River, *A.A. Hamilton and A.H.S. Lucas*, 4.x.1915 (NSW *398968*).

Description of Australian Specimens: Vegetative cells 39-160 µm long, 24–27 µm in diameter, end-walls plane.

Taxonomic Assessment: *Mougeotia capuciua* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 70–280(–340) µm long, 14–21 µm in diameter, usually violet coloured, 1 or 2 chloroplasts either rod-shaped occupying one-third to one quarter of the cell with 4–8 pyrenoids, or ribbon-like occupying three-fourths of the cell with 12–16 pyrenoids in a single row; conjugation scalariform; sporangia dividing both gametangia; zygospores extending into the gametangial cell, irregularly quadrate with concave sides, 60–100 µm long, 45–70 µm in diameter, middle wall thick, smooth and violet to brown; aplanospores 45–70(–80) µm long, 20–36 µm in diameter. The Australian herbarium material has narrower filaments than reported generally for *M. capucina* and in the absence of fertile material this determination cannot be confirmed. The Sonder (1852, 1880) reports include no supporting documentation and are not vouchered.

Mougeotia decussata Kütz., *Phycol. Germ.* 222 (1845).

This species was reported by Kützing (1882b) from Ballarat, Victoria.

Mougeotia elegantula Wittr., *Gotl. Ölands Sötv.-alg.* 40 (1872).

This species was reported by Playfair (1917) from New South Wales.

Mougeotia genuflexa (Dillwyn) C. Agardh, *Syst. Alg.* 83 (1824). *Conferva genuflexa* Dillwyn, *Brit. Confev.* pl. 6: 51 (1809).

Known Distribution: North America, Europe, Africa, Asia.

Specimen Reported: QUEENSLAND: Lake Broadwater, *J.A. Grimes*, xi.1986 (Grimes 1988).

Description of Australian Specimens: Vegetative cells 150 µm long, 20 µm in diameter; conjugation lateral and scalariform; zygospores forming in the conjugation tube (calculated from illustration in Grimes 1988).

Taxonomic Assessment: *Mougeotia genuflexa* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 50–225 µm long, 25–40 µm in diameter, frequently geniculate and interconnected, thus forming extensive nets; conjugation usually lateral (sometimes scalariform with zygospores not extending into either gametangia); zygospores quadrately ovoid to globose, 30–40 µm in diameter, middle wall smooth and yellow-brown to brown. The dimensions and mode of conjugation illustrated by Grimes (1988) are consistent with the above published accounts of *M. genuflexa* but also match at least five other species. Without further information we prefer to reject this taxon from Australia.

Mougeotia gracillima (Hassall) Wittr., *Bih. Kongl. Svenska Vetensk.-Akad. Handl.* 1: 40 (1872). *Staurocarpus gracillimum* Hassall, *Ann. Nat. Hist.* 12: 185, pl. 7 fig. 6 (1843).

This species was reported by Hardy (1906) from Sandringham, Victoria.

Mougeotia laevis (Kütz.) W. Archer, *Quart. J. Microscop. Soc.* 6: 272; 7: pl. 8 figs 1–3 (1866). *Zygogonium laeve* Kütz., *Sp. alg.* 447 (1849); *Debarya laevis* (Kütz.) West & G.S. West, *J. Roy. Microscop. Soc. London* 476 (1897).

This species was reported by Playfair (1917, as *Debarya laevis*) from New South Wales.

Mougeotia nummuloides (Hassall) De Toni, *Syll. Alg.* 1: 713 (1889). *Mesocarpus nummuloides* Hassall, *Hist. Brit. Freshwater Alg.* 169, t. 45 fig. 1 (1845).

Known Distribution: North America, Europe, Africa.

Specimen Examined: QUEENSLAND: Nerang River, Ships Stern area, *A.B. Cribb 845.3*, 14.vi.1976 (BRI).

Description of Australian Specimens: Vegetative cells 18–36 µm in diameter, zygospores 33–51 µm in diameter, middle wall yellow-green.

Taxonomic Assessment: *Mougeotia nummuloides* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 32–160 µm long, 8–16 µm in diameter, chloroplasts with 2–6 pyrenoids in a row; conjugation scalariform (gametangia slightly bent); zygospores in the conjugating tubes, globose to ovoid (17–)22–23(–37) µm in diameter, middle wall brown, scrobiculate; aplanospores ovoid, within the angled sporogenous cell. The measurements taken from the Queensland specimen are substantially larger than those reported generally for *M. nummuloides*. As the specimen examined is so poorly preserved, it cannot be confidently identified.

Mougeotia oblongata Transeau, *Trans. Amer. Micros. Soc.* 53: 219, fig. 38 (1934).

Known Distribution: North America.

Specimen Reported: QUEENSLAND: Blunder, *J. Peberdy* [s. d.] (McLeod 1975).

Description of Australian Specimens: Vegetative cells 72–110 µm long, 9–10.5 µm in diameter; chloroplasts with 6 pyrenoids in a row; conjugation scalariform; zygospores 16–18.5 µm long, c. 14 µm in diameter, formed in the conjugation tube, bilobate-ovoid, middle spore wall smooth and yellow.

Taxonomic Assessment: *Mougeotia oblongata* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 80–200 µm long, 14–22 µm in diameter; chloroplasts with 6–12(–16) pyrenoids in a row; conjugation scalariform, often connecting several filaments; zygospores usually bilobate-ovoid, sometimes more cylindrical with concave sides, 47–58 µm long, 28–36 µm in diameter, formed in the conjugation tube, middle wall yellow, sometimes finely punctate. The middle wall appeared smooth in the Queensland collection, and the dimensions of the zygospores and filaments are considerably smaller than those above. Although the characteristic zygospore shape and location match *M. oblongata*, the differences are too substantial to accept the record for Australia. It is possible that this record represents a new taxon.

Mougeotia parvula var. ***angusta*** (Hassall) Kirchn. in Cohn, *Krypt.-Fl. Schlesein* 128 (1878). *Mesocarpus angustus* Hassall, *Hist. Brit. Freshwater Alg.* 170, pl. 45 fig. 4 (1845).

This variety was reported by West (1909) from Yan Yean Reservoir, Victoria.

Mougeotia poinciana Transeau, *Trans. Amer. Microscop. Soc.* 53: 224 (1934).

Known Distribution: North America.

Specimen Reported: NORTHERN TERRITORY: Alligator River Region, Coonjimba Billabong, *H.U. Ling and P.A. Tyler*, 13.v.1978 (Ling and Tyler 1986).

Description of Australian Specimens: Vegetative cells 170–200 µm long; 15–17 µm in diameter; zygospores c. 42 µm in diameter.

Taxonomic Assessment: *Mougeotia poinciana* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1984; Dillard 1990) by vegetative cells 100–200 µm long, 21–25 µm in diameter, chloroplasts with 6–10 pyrenoids in a single series; conjugation scalariform; gametangia bent; zygospores mostly within the female gametangium, sometimes extending somewhat into the conjugation tube, triangular-ovoid to globose, 35–51 µm long, 36–44 µm in diameter, (sporangium dividing one of the gametangia), middle wall smooth and yellow; aplanospores obliquely ovoid, 32–48 µm long, 24–30 µm in diameter. The zygospore diameter and reproductive morphology illustrated by Ling and Tyler (1986) match other published accounts, but the cell dimensions are contrary. *Mougeotia floridana*, in the same section (*Plagiospermum*) as *M. poinciana*, has filaments 14–20 µm in diameter (Dillard 1990), similar to those of the Australian record. In addition, the illustrations of *M. floridana* in Transeau (1951) and Bourrelly (1990) match the Australian illustration. However, according to Kadłubowska (1984), *M. floridana* has globose to tri-lobed zygospores located within the female gametangium (only rarely slightly extending into the conjugation tube) features not obvious in the Australian illustration. Transeau (1951) states that the zygospores in *M. floridana* occupy the middle of the receptive gametangia and the tubes, a feature also not present in the Australian material. On reproductive morphology the name *M. floridana* is inapplicable, and the vegetative differences between the Northern Territory collection and *M. poinciana* are substantial , so we reject this name too pending further study. It is possible that this record represents a new taxon.

Mougeotia recurva (Hassall) De Toni, *Syll. Alg.* 1: 714 (1889). *Mesocarpus recurvus* Hassall, *Hist. Brit. Freshwater Alg.* 168 (1845).

Known Distribution: Canada, North and South America, Europe, India.

Specimen Reported: VICTORIA: Yan Yean Reservoir, *G.S. West*, xi.1905 (West 1909).

Specimen Examined: QUEENSLAND: Stream on Mt Coot-tha, *A.B. Cribb 968.3*, 21.iv.1983 (BRI).

Description of Australian Specimens: Vegetative cells 12–14 µm diameter, zygospores 25–28 µm diameter; aplanospores globular and cylindrical, 34 µm long, 14–24 µm in diameter (from West 1909). Vegetative cells 80–140 µm long, 18–30 µm in diameter, with 3–6 pyrenoids; no fertile material seen (*A.B. Cribb 968.3*, BRI).

Taxonomic Assessment: *Mougeotia recurva* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 50–180 µm long, (10–)12–18 µm in diameter, chloroplast with 4–8 pyrenoids in a single series; conjugation scalariform; gametangia only slightly bent; zygospores globose, 22–33 µm in diameter, wholly within the conjugation tube, middle wall smooth and brown; aplanospores globose, 24–30 µm in diameter at bends in geniculate cells or cylindrical-ovoid, 28–34 µm long , 14–18 µm in diameter in straight cells. West (1909, 50) observed only a few individuals and suggested 'they differed [from one another] in the proportionately longer vegetative cells and in the straightness of the conjugating cells. The specimens observed were probably abnormal states, as some of the filaments had produced both globular and cylindrical aplanospores, the former (diameter 24 µm at the outer angles of geniculate cells, and the latter (long. 34 µm; lat. 14 µm) in the middle of straight

cells.' West (1909) was uncertain about the determination of this species. The measurements by West match those reported generally for *M. recurva*, but due to West's own uncertainty and the lack of additional material, a definite identification can not be made. The Queensland material had broader filaments than generally reported for this species, and without fertile material, it too can not be confidently identified.

Mougeotia violacea Kütz., *nom. nud.* (Day *et al.* 1995).

This species was reported by Kützing (1882b) from Ballarat, Victoria.

Mougeotia viridis (Kütz.) Wittr., *Bih. Kongl. Svenska Vetensk.-Akad. Handl.* 1: 39 (1872).

Staurospermum viridis Kütz., *Phycol. General.* 278 (1843).

This species was reported by May (1972) from Braidwood, New South Wales; Nobel & Happey-Wood (1987) from central southern New South Wales; and West (1909) from Yan Yean Reservoir, Victoria.

Sirogonium sticticum (Sm.) Kütz., *Phycol. General.* 278 (1843).

Conferva stictica Sm., *Eng. Bot.* 35: t. 2463 (1813); *Spirogyra stictica* (Sm.) Wille *Bihang Till K. Sv. Vet.-Akad. Handlingar* 8(18): 34 (1884).

Known Distribution: Asia, Africa, Europe, South and North America.

Specimens Reported: QUEENSLAND: Herston Road, Brisbane, *W.J. Bryam*, 1898 (Schmidle 1896, Bailey 1898; 1913), Ashgrove, *J.A. McLeod*, [s. d.] (McLeod 1975). NEW SOUTH WALES: Aberfoyle River, *S. Skinner*, iii, vii-x.1974 (Skinner 1980); Falconers Creek, *S. Skinner*, xii.1974 (Skinner 1980); Little Guyra Lagoon, *S. Skinner*, xii.1974 (Skinner 1980); Cooney Creek, near Hillgrove, *S. Skinner*, xii.1974 (Skinner 1980). VICTORIA: Hatherley, *J. Stickland*, 1897 (Stickland 1897).

Description of Australian Specimens: Vegetative cells 130–160 µm long, 60–65 µm in diameter; zygospores 65–70 µm in diameter.

Taxonomic Assessment: *Sirogonium sticticum* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Dillard 1990) by vegetative cells, 80–300 µm long, 38–56 µm in diameter; 3–6 chloroplasts, nearly straight or making 0.5 turn; conjugation directly between usually shortened and somewhat reflexed gametangia; zygospores ellipsoid or ovoid (66–)68–127 micrometres long, 40–67(–90) µm in diameter, middle wall smooth, yellow, often with a distinct fissure line. The New South Wales records are described by slightly larger filaments than reported elsewhere in the literature and no fissure line was noted on the zygospores. The description given by Skinner (1980) seems closer to that of *S. floridanum* (references cited above). As there are no descriptions or illustrations of the remaining Australian specimens, we reject this name pending further evidence. Without details about chloroplast and reproductive morphology we cannot confirm that the genus *Sirogonium* occurs in Australia.

Spirogyra alpiuum Kütz., *Sp. alg.* 439 (1849). ?'*Zygogonium alpinum* Kütz.'

This species was reported by Sonder (1880, 1881; both as '*Zygogonium alpinum*') from Victoria.

Spirogyra cateuaeformis (Hassall) Kütz., *Sp. alg.* 438 (1849). *Zygnema catenaeformis* Hassall, *Ann. Nat. Hist.* 10: 39 (1842).

This species was reported by Skinner (1989; as '*S.* sp. aff. *S. catenaeformis*') from Dalhousie Springs.

Spirogyra condensata (Vaucher) Kütz., *Phycol. General.* 279, t. 5, fig. 2 (1843).
Conjugata condensata Vaucher, *Hist. Conferv. Eau Douce* 67, pl. 5 fig. 2 (1803).
This species was reported by Hardy (1906) from Berwick, Victoria, and Watts (1887) from Victoria.

Spirogyra crassa (Kütz.) Kütz., *Phycol. General.* 280, pl. 14 fig. 4 (1843).
Zygnema crassum Kütz., *Alg. Aq. Dulc. Germ.* No. 98 (1834).
Known Distribution: North America, Europe, South Africa, India, New Zealand.
Specimens Reported: QUEENSLAND: Port Curtis District, *M. Moebius*, v–vi.1893 (Moebius 1895; Bailey 1895, 1913; Pigram 1909); University Lake, St Lucia, Schultz's Clayfield, Indooroopilly, Upper Brookfield, [s. d.] (McLeod 1975). NEW SOUTH WALES: Lismore, Wyrallah Road, *G.I. Playfair*, 1914 (Playfair 1915, 1917); Murray Valley, [collector not cited], 1987 (Noble and Happey-Wood 1987).
Specimen Examined: NEW SOUTH WALES: Campsie, *A.H.S. Lucas*, 1916 (NSW).
Description of Australian Specimens: Vegetative cells 115–190 µm (sometimes 50 µm; Playfair 1915) in diameter; as long as or somewhat longer than broad, wall thin (c. 2 µm thick; Playfair 1915); chloroplasts 4–6, narrow, making 1–1.5 turns, pyrenoids very numerous, and large relative to the width of the chloroplast.
Taxonomic Assessment: *Spirogyra crassa* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 126–330 µm long, (108–)126–165 µm in diameter, with plane end-walls; chloroplasts 6–12 making 0.5 of a spiral; pyrenoids numerous, large; conjugation scalariform, conjugation tubes formed equally by both gametangia, fruiting cells not swollen; zygospores ovoid to globose, 120–175 µm long, 80–100 µm in diameter, middle wall with irregularly distributed shallow pits (smooth; Randhawa 1959), brownish. Published descriptions of *S. crassa* vary between the monographs cited as well as between Australian reports. All Australian collections, except those reported by McLeod (1975), have generally fewer chloroplasts turning more times than those of overseas reports and these reports of the species are rejected. McLeod's record cannot be verified.

Spirogyra dubia Kütz., *Tab. Phycol.* 5: 8, pl. 24 fig. 4 (1855).
Known Distribution: North America, Europe, Africa, China.
Specimen Reported: QUEENSLAND: [s. loc., s. d.] (Pigram 1909).
Description of Australian Specimens: Vegetative cells 1.5–4 times as long as broad, end-walls plane; chloroplasts 2 making 1–2.5 turns; conjugation scalariform, conjugation tube formed equally by both gametangia; gametangia slightly swollen; zygospores ellipsoid to orbicular (calculated from illustration in Pigram 1909).
Taxonomic Assessment: *Spirogyra dubia* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dias 1992) by vegetative cells 40–50 µm in diameter, 1.5–5 times as long as broad, with plane end-walls; chloroplasts 2–3, making 2–8.5 turns; conjugation scalariform; gametangia largely swollen; zygospores oval to ellipsoid, 54–104 µm long, 40–65 µm in diameter, middle wall thick, smooth and brown. There are a number of species consistent with Pigrams drawings, including *S. irregularis, S. welwitschii* and *S. hymerae*. Without further information, such as vegetative cell dimensions, the determination cannot be confirmed and we reject the name *S. dubia*, for the Australian taxon.

Spirogyra flavescens (Hassall) Kütz., *Sp. alg.* 438 (1849). *Zygnema flavescens* Hassall, *Hist. Brit. Freshwater Alg.* 149, pl. 30 fig. 9–10 (1845).
Known Distribution: North America, Europe, Africa, Asia.

Specimens Reported: QUEENSLAND: [s. loc., s. d.] (Pigram 1909). VICTORIA: Albert Park Lake, *A.D. Hardy*, 30.xi.1954 (Hardy 1931–1956).

Description of Australian Specimens: Vegetative cells 20–21 µm in diameter, end-walls 'truncate' (Pigram 1909).

Taxonomic Assessment: *Spirogyra flavescens* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984; Dillard 1990; Kargupta and Sarma 1992) by vegetative cells 30–50 µm long (74–137 µm; Kargupta and Sarma 1992), 10–17 µm in diameter, with plane end-walls; chloroplast single, very thin, making 1–3 turns; conjugation scalariform (and lateral, Randhawa 1959), conjugation tubes formed equally by both gametangia; gametangia are distinctly swollen; zygospores long, ellipsoid to ovoid, 25–59 µm long, 18–23 µm in diameter; outer wall thin and brown, middle wall smooth and yellow (or bluish green; Randhawa (1959). Pigram's (1909) illustration is taken from Petit (1880) and the dimensions of the vegetative filament provided by Petit are outside the range reported generally for *S. flavescens*. Hardy's (1931–56) report is based on a vegetative specimen and includes no documentation. *Spirogyra flavescens* is therefore rejected from the census.

Spirogyra flavicans Kütz., *Tab. Phycol.* 5: 7, tab. 5, t. 23 fig. 3 (1855).

This species was reported by Hardy (1906) from Berwick, Victoria, Kützing (1882a) [as '*S. flavicans* var. artic. *longioribus*'] from Port Phillip, Victoria, and Watts (1887) from Victoria. This taxon is treated as *Spirogyra decimina* var. *flavicans* (Kütz.) Rabenh. by De Toni (1889).

Spirogyra fluviatilis Hilse in Rabenh., *Fl. Eur. Alg.* 3: 243 (1868).

This species was reported by Berg (1953) from the Upper Finke River, Northern Territory.

Spirogyra gracilis (Hassall) Kütz., *Sp. alg.* 438 (1849). *Zygnema gracile* Hassall, *Hist. Brit. Freshwater Alg.* 155, pl. 34 fig. 6 (1845).

This species was reported by Kützing (1882b) [s. loc.] and West (1909; also as '*S.* sp. (probably *gracilis*)') from Yan Yean Reservoir, Victoria.

Spirogyra hassallii (Jenner) Petit, *Spirogyra Paris* 13, pl. 2 figs 6–8 (1880). *Zygnema hassallii* Jenner, *Fl. Tunbridge Wells* 182 (1845).

This species was reported by Playfair (1917) from New South Wales.

Spirogyra lismorensis *nom. illeg.* Playfair, *Proc. Linn. Soc. New South Wales* 39: 98 (1914).

Known Distribution: Australia.

Specimens Reported: NEW SOUTH WALES: Richmond and Nymboida Rivers, *G.I. Playfair*, xii.1912–i.1913 (Playfair 1914, 1918).

Description of Australian Specimens: Vegetative cells 80–300 µm long, c. 14 µm in diameter, end-walls replicate, chloroplast single broad, twisted round its long axis, making 5–15 turns, edges somewhat laciniate.

Taxonomic Assessment: Playfair (1914, 98), in describing this species, stated 'I have given this curious and interesting form a name, but I do not consider it a distinct species.' Under article 34 of the ICBN (Greuter 1994), *Spirogyra lismorensis* must therefore be treated as an illegitimate name. In addition, the only material on which the name was based is sterile so no species determination is possible.

Spirogyra lubrica Kütz., *nom. nud.* (Day *et al.* 1995).
This species was reported by Kützing (1882b) from Victoria.

Spirogyra lutetiana Petit, *Brébissonia* 1: 79, pl. 6 (1879).
This species was reported by Laird (1956) from Toonpan Creek, Queensland.

Spirogyra majuscula Kütz., *Sp. alg.* 441 (1849).
This species was reported by Hardy (1906) from Deepdene, South Australia, Kützing (1882b) [s. loc.] and Watts (1887) from Victoria.

Spirogyra pellucida (Hassall) Kütz., *Sp. alg.* 439 (1849). *Zygnema pellucidum* Hassall, *Hist. Brit. Freshwater Alg.* 143, pl. 25 figs 1, 2 (1845).
This species was reported by Hardy (1906) from Deepdene, South Australia, Kützing (1882a) from Port Phillip, Victoria, and Watts (1865, as *Zygnema pellucidum*; 1887) from Victoria.

Spirogyra pseudoneglecta Czurda, *Süsswasserflora* 9: 194 (1932).
This species was reported by Laird (1956) from Civil Airfield, Cairns, Queensland.

Spirogyra punctata Cleve, *Nova Acta Regiae Soc. Sci. Upsal.* ser 3, 6: 23, pl. 4 figs 1–4 (1868).
All reports (Pigram 1909, Mc Leod 1975) of *Spirogyra punctata* from Australia are based on Moebius's var. *tenuior* (see that taxon above).

Spirogyra quadrata (Hassall) Petit, *Bull. Soc. Bot. France* 21: 41, pl. 1 fig. 2 (1874). *Zygnema quadratum* Hassall, *Hist. Brit. Freshwater Alg.* 157, pl. 37 figs 1, 2 (1845).
This species was reported by West (1909) from Yan Yean Reservoir, Victoria.

Spirogyra rectangularis Transeau, *Amer. J. Bot.* 1: 291, pl. 25 figs 9–11 (1914).
Known Distribution: North America, Europe, Australia.
Specimen Reported: QUEENSLAND: University Lake, St Lucia, *J.A. McLeod*, [s. d.] (McLeod 1975).
Description of Australian Specimens: Vegetative cells 170–210 µm long, 35–40 µm in diameter, with replicate end-walls; chloroplasts 2, making 4 turns; no reproductive stages observed.
Taxonomic Assessment: *Spirogyra rectangularis* is characterized (Transeau 1951; Randhawa 1959; Kadłubowska 1972, 1984; Dillard 1990) by vegetative cells 150–320 µm long, 35–40 µm in diameter, end-walls replicate; chloroplasts 2–4 making, 2–5 turns; conjugation scalariform and lateral; conjugation tubes formed equally by both gametangia (principally by male gametangia, Dillard 1990); gametangia cylindrically inflated to 48–70 µm; zygospores ovoid to cylindrical-ovoid, 75–120 µm long, 45–65 µm in diameter, middle wall smooth and yellow-brown. Although the Queensland collection matches the above description in its vegetative characters, without reproductive material it could be a number of species: e.g. *S. cleveana, S. borysthenica, S. areolata*. *Spirogyra rectangularis* is therefore rejected from our census.

Spirogyra weberi Kütz., *Phycol. General.* 279 (1843).

This species was reported by Playfair (1917) from New South Wales.

Spirogyra westii Transeau, *Trans. Amer. Microscop. Soc.* 53: 224 (1934).

Known Distribution: Africa, India.

Specimens Reported: NEW SOUTH WALES: Major Creek, Howell near Tinga, *Garrard*, iv-vii.1974 (Skinner 1980); Sandy Creek, near the dog-gate, Armidale-Dorrigo Road, *S. Skinner*, xii.1974 (Skinner 1980).

Description of Australian Specimens: Vegetative cells 20–25 µm in diameter, 4–5 times as long as broad, end-walls lenticular; chloroplast single, making 4–7 turns, pyrenoids numerous; conjugation scalariform, 'conjugation tube of two cups, towards one end of both donor and receiver cells, a little more terminally in the slightly inflated receiving cell'; zygospores ellipsoid, 65–70 µm long, 30–35 µm in diameter, suture line median, middle wall golden brown.

Taxonomic Assessment: *Spirogyra westii* is characterized (Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984) by vegetative cells 60–160 µm long, 36–41 µm in diameter, with plane end-walls; chloroplast single, making 3–5 turns; conjugation scalariform, conjugation tubes formed equally by both gametangia; gametangia enlarged; zygospores ellipsoid or ovoid, 56–93 µm long, 35–38 µm in diameter, middle wall finely wrinkled or corrugate. The diameter of the vegetative filaments given by Skinner (1980) is considerably smaller than that in the description above, and the middle wall ornamentation is not described. The name *S. westii* is therefore rejected for Australia pending further evidence (no voucher specimens are housed at AD).

Zygnema aequale (Kütz.) De Toni, *Syll. Alg.* 1: 739 (1889). *Zygogonium aequale* Kütz., *Phycol. Germ.* 225 (1843).

This species was reported by Kützing (1882b, as *Zygogonium aequale*) from Ballarat, Victoria.

Zygnema gorakhporense Rama N. Singh, *J. Indian Bot. Soc.* 17: 370 (1938).

This species was reported by Laird (1956) from 16 km south of Townsville and Toonpan Creek, Queensland.

Zygnema leiospermum de Bary, *Unters. Conjugaten* 77, pl. 1 figs 7-14 (1858).

Known Distribution: North America, Greenland, Iceland, Europe.

Specimens Reported: QUEENSLAND: Lagoon, Isis, *J.A. McLeod*, [s. d.] (McLeod 1975); Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1892; Bailey 1893, 1913). VICTORIA: Yan Yean Reservoir, *G.S. West*, ix.1907 (West 1909).

Description of Australian Specimens: Vegetative cells 22–24 µm in diameter, 1–1.5 (rarely less) times as long as broad, slightly constricted at the end-walls.

Taxonomic Assessment: *Zygnema leiospermum* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Kadlubowska 1972, 1984) by vegetative cells 20–40 µm long, 20–24 µm in diameter; conjugation scalariform; female gametangia greatly inflated, zygospores globose to ovoid, 23–32 µm long, 23–30 µm in diameter, middle wall smooth and brown; aplanospores similar to zygospores, but smaller in diameter. The description given by McLeod (1975) seems to be taken from published sources and her report cannot be accepted here. The vegetative filaments described by Moebius (1892) are consistent with *Z. leiospermum* as generally reported, but they also match species such as *Z. tenue*, *Z. calosporum* and

Z. peliosporum. The Victorian record is not documented at all. Pending further information, therefore, the name is rejected from our census.

Zygnema ralfsii (Hassall) de Bary, *Unters. Conjugaten* 77 (1858). *Tyndaridea ralfsii* Hassall, *Hist. Brit. Freshwater Alg.* 165, t. 39 figs 4-5 (1845).

Known Distribution: North America, Europe, Africa.

Specimen Examined: NEW SOUTH WALES: Woy Woy, *A.A. Hamilton*, vi.1915 (NSW).

Description of Australian Specimens: Zygospores globose to ellipsoid-globose, 27–39 µm long, 18–27 µm in diameter, middle wall scrobiculate and golden, pits c. 3 µm in diameter.

Taxonomic Assessment: *Zygnema ralfsii* is characterized (Borge 1913; Transeau 1951; Randhawa 1959; Gauthier-Liévre 1965; Kadłubowska 1972, 1984) by vegetative cells 38–80 µm long, 14–22 µm in diameter; conjugation scalariform; zygospores formed in the conjugation tubes, 24–35 µm long, 15–25 µm in diameter, middle wall smooth and brown. Only zygospores were found in the herbarium specimen and although they were of a similar size to those reported for *Z. ralfsii*, the middle wall was clearly scrobiculate rather than smooth. The name *Z. ralfsii* is therefore rejected from our census and without further documentation this collection cannot be identified.

Zygnema rhynchonema Hansg., *Hedwigia* 27: 257 (1888).

Known Distribution: Europe, North Africa.

Specimen Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1895; Bailey 1895, 1913).

Description of Australian Specimens: Vegetative cells c. 17 µm in diameter, 3–5 times as long as broad, walls thin, smooth; conjugation lateral; 'zygospore lies directly over, in front of the septum of both the conjugating cells', immature zygospores c. 38 µm in diameter.

Taxonomic Assessment: *Zygnema rhynchonema* is characterized (Borge 1913; Gauthier-Liévre 1965; Kadłubowska 1972, 1984) by vegetative cells 16–20 µm in diameter, 2–6 times as long as broad; conjugation lateral; zygospores formed middle of conjugation tube, globose to ellipsoid, 30–35 µm long, 27–33 µm in diameter, middle wall smooth and blue. The cell dimensions of the Australian report match those generally reported for *Z. rhynchonema*, however, the zygospores are larger and there is no mention of the distinctive blue colour. Without further documentation this collection cannot be identified and the name *Z. rhynchonema* is rejected from our census.

Zygnema rivulare Hassall, *Ann. Nat. Hist.* 10: 38 (1842).

This species was reported by Watts (1865) from the Yarra River, Victoria.

Zygnema stellinum (Vaucher) C. Agardh, *Syst. Alg.* 77 (1824). *Conferva stellina* Vaucher, *Hist. Conferv. Eau Douce* 75 pl. 7 fig. 1 (1803).

This species was reported by Hardy (1906) from Royal Botanic Gardens, Melbourne, Victoria; Hardy (1931-56, as '*Zygnema stelligera*' [presumably in error]) from Yan Yean Reservoir, Victoria; Kützing (1882b; also '*Zygnema stellinum* ß') from Ballarat, Victoria, and Sonder (1852, 1880) from Tasmania.

Zygnema subtile Kütz., *Sp. alg.* 444 (1849).

This species was reported by Kützing (1882b) from Melbourne and Barwon River, Victoria.

Zygnema tenue Kütz., *Sp. alg.* 445 (1849).

This species was reported by Kützing (1882b) from Barwon River, Victoria.

Zygnema tenuissimum Grunov in Rabenh., *Fl. Eur. Alg.* 3: 251 (1868), *non* Hassall (1845).

Known Distribution: Europe.

Specimen Reported: QUEENSLAND: Burpengary, Brisbane, *T.L. Bancroft*, iii.1893 (Moebius 1892, 1895; Bailey 1893, 1913).

Specimen Examined: QUEENSLAND: Stony Creek, Blackdown Tableland, *A.B. Cribb 801.14*, 3.ix.1974 (BRI; Cribb 1976).

Description of Anstralian Specimens: Vegetative cells c. 9 µm in diameter, 10 times as long as broad; zygospores formed in the conjugating tube, spherical and brown, 16–20 µm in diameter.

Taxonomic Assessment: De Toni (1889) gives the same cell dimensions as above for *Zygnema tennissimum* Grunov. However, the name *Z. tenuissimum* Grunov is a later homonym of *Z. tennissimum* Hassall and is thus illegitimate. From the published description in Moebius (1892), the Bancroft collection is referable to *Z. spontaneum*. We were unable to identify the Cribb collection from the permanent slide available, but as Cribb (1976) reports it as '*Z. tenuissimum* Grun. *sensu* Moebius' it may be the same taxon.

Zygnemopsis desmidioides (West & G.S. West) Transeau, *Trans. Amer. Microscop. Soc.* 53: 215 (1934). *Debarya desmidioides* West & G.S. West, *J. Bot.* 1903: 7, pl. 446 figs 1–9 (1903).

This species was reported by Playfair (1917, as *Debarya desmidioides*) from New South Wales.

Zygogonium* [*Zygnema*] *affine Kütz., *Tab. Phycol.* 5: 4, pl. 12 fig. 3(1855).

This species was reported by Sonder (1880, 1881) from Tasmania.

Zygogonium laeve Kütz., *nom. nud.* (Day *et al.* 1995).

This species was reported by Kützing (1882b) from Melbourne, Victoria.

Zygogonium tenue Kütz., *Sp. alg.* 445 (1849).

This species was reported by Kützing (1882b) from Hawkesbury River, New South Wales.

Discussion

The nature of species in the Zygnemataceae has been, and continues to be, confusing. Hoshaw and McCourt (1988) suggest that *Spirogyra* and indeed the family, needs a thorough revision because of widespread polyploidy. McCourt *et al.* (1986) found correlation between filament width and nuclear-DNA content in a series of *Spirogyra* filaments collected from various habitats across continental USA, suggesting

'that species complexes in this genus may be widespread.' Hoshaw and McCourt (1988, 540) concluded that there were far fewer than the 386 species of *Spirogyra* included in Kadlubowska (1984). In Andersen (1992, 274), Hoshaw is quoted as saying that due to widespread polyploidy, 'the number of *Spirogyra* species [world-wide] is about 50 rather than 300', ultimately 'the definition of a species in this genus may need to be revised to include morphotypes of a species complex in the same species' (Hoshaw and McCourt 1988, 540).

The taxa accepted in this study form a first and tentative census of Zygnemataceae in Australia. For a family so diverse, so widespread and so patently common, the extent of collecting in Australia is woeful. This is due part to the difficulty in identifying sterile material, and in part to the overlapping and imprecise species definition and circumscription alluded to above.

The key we provide will assist in this process but is no substitute for a thorough taxonomic revision of the family in Australia involving culture studies, examination of type material and detailed population studies. The census and the key will give future collectors a relatively simple and consistent starting point. Clearly this paper does not fully document the diversity of Zygnemataceae in Australia. If our results induce collecting, identification, taxonomic revision and dissent we will have achieved our aim.

Acknowledgments

Thanks to curators of AD, BRI, CANB and NSW for loans of specimens and The R.E. Ross Fund for financial support of this project.

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